SOCIAL PERCEPTION, EMPATHY FOR PAIN AND ATTACHMENT

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Abstract

The purpose of this study was to investigate how attachment anxiety and empathy for experimentally stimulated pain influenced participants' attention to negative social stimuli as measured with the Event-Related Potentials technique. Participants underwent a cold-bottle pain stimulation task, after which they were given a manipulated empathy rating from a falsified unfamiliar observer. Participants then completed an oddball discrimination task wherein they were expected to select a button for rare angry-faced pictures and ignore more frequent neutral-faced pictures. Neural correlates of attention, as measured by the P300 component for angry-faced images, were then analyzed. While no group differences were observed for participants with low attachment anxiety, among those with high attachment anxiety, participants who were given high empathy demonstrated lower P300 amplitudes, suggestive of less attention for the angry-faced images, than participants given low empathy. Accordingly, participants with high attachment anxiety appeared to benefit from the empathy of the falsified unfamiliar observer in modulating their own attention to the unpleasant social stimuli. There are clinical implications of the findings that can be useful for psychologists treating patients with attachment anxiety who are coping with chronic pain.

Social Perception, Empathy for Pain and Attachment

According to the Institute of Medicine (2011) chronic pain affects over 100 million Americans at a cost of over $635 billion per year. Taylor (2012) explained that chronic pain, unlike acute pain, lasts 6 months or more after injury and either maintains severity or increases in severity over time. This condition is associated with a variety of ailments from depression to physical dysfunction (Jensen & Turk, 2014). Jensen and Turk have noted patients with chronic pain should be matched "to particular treatments based on relevant predictive characteristics" (Jensen & Turk, 2014, p. 114). Such emphasis is consistent with Evidence-Based Practice in Psychology (EBPP), which stresses "the integration of the best available research with clinical expertise in the context of patient characteristics, culture and preferences" (APA Presidential Task Force, 2006, p. 273). Despite the myriad of coping strategies with demonstrable effectiveness in managing chronic pain, attempts to customize pain treatments for patients have been limited, instead favoring a "one size fits all approach" (Forys & Dahlquist, 2007, p. 22).

Attachment and empathy have emerged as constructs of interest in the study of chronic pain. Researchers have established empathy and attachment are capable of influencing physical pain perception (e.g., Hurter, Paloyelis, Williams & Fotopoulou, 2014; Sambo, Howard, Kopelman, Williams & Fotopoulou, 2010). The next step is to study how empathy in the context of attachment may influence physiological indicators of emotional adjustment to pain. There is evidence that negative emotions are linked with pain disorders and that negative mood states result from a combination of biases in information processing and pain (Meredith et al., 2008).

Attention may be an important variable for studying the relationship between empathy, adjustment to pain and attachment. Coan (2008) recently described a neuroscientific approach to attachment, suggesting that attachment influences emotional regulation by altering one's

perceptions of threat in the environment. According to this theory, securely attached persons who are in the presence of a caring other experience a reduction in self-regulatory neurological activity because they have less need to attend to the threats within their surroundings. In the present study, I will seek to extend past research on the influence of empathy on pain adjustment by addressing how empathic support for pain from others, in the context of participants' attachment, influences the allocation of neurobiological attentional resources.

Pain

Definitions of pain have been characterized by numerous paradigm shifts (Gatchel et al., 2014). Gatchel and colleagues described two biomedical models that were derived from the Cartesian notion that there is a direct relationship between tissue damage and pain (2007). Specificity Theory holds that information about pain is transduced from peripheral afferents to the brain through the spinal cord via "unique receptor mechanisms and pathways" (Gatchel et al., 2007, p. 582). Alternatively, Pattern Response Theory suggests that information about pain is the result of the intensity of the stimulus along with a "pattern of response" in the systems, which transmit to the brain (Gatchel et al., 2007, p. 582). So, while Specificity Theory held that a specific pathways and receptors carried information about pain, Pattern Response Theory held that rather than specific systems, patterns of response within afferent systems determined one's response to pain. Ultimately, managing pain without consideration for psychological or social inputs limited the usefulness of these theories, as consideration of non-physical concomitant elements introduces additional means of treating pain that have been proven efficacious (Gatchel et al., 2014).

Pain and disability within the context of the biopsychosocial model can be seen as a "complex and dynamic interaction among physiological, psychological, and social factors that

perpetuate, and even worsen, one another, resulting in chronic and complex pain syndromes" (Gatchel et al., 2014, p. 120). This model also recognizes that there is no simple correspondence between pathology or nociception and pain experience (Gatchel et al., 2014). Instead, according to Gatchel and colleagues, emotions and cognitions are seen as influencing biologically-based pain processes, and capable of amplifying pain experience.

Attachment

Preceding any discussion of the influence of attachment on physical or psychological pain experience, I will briefly define this construct. Bowlby (1977) described attachment in terms of one's behavior in securing and retaining relationships with close others. He indicated the importance of attachment behavior early in one's life, as children appear to use an attachment figure, usually the mother, as a "secure base" from which to explore the world. Such relationships become internal working models for the child eventually becoming a trait-like characteristic influencing his or her ability to relate to others throughout the lifespan.

Conceptualizations of Attachment

Although it is yet unclear whether attachment is inherently categorical or dimensional, both means have been used to describe this construct (Forsythe et al., 2012). Meredith, Ownsworth and Strong (2008) stated the categorical model with greatest acceptance is that of Bartholomew and Horowitz (1991). Bartholomew and Horowitz structured their model on Bowlby's conceptualization of attachment behavior existing on axes of a *model of self* or *other*. The model of self was considered to relate to one's perception of worthiness for help and support while the model of other related to one's perception of the availability and reliability of attachment figures. Individuals could be conceived along either of these two continuous dimensions, or these dimensions could be combined to identify categorical attachment styles.

Persons who have both a positive model of self and a positive model of others are labeled as secure while those who have both a negative model of self and others are labeled as fearful. Those who have a positive model of self but a negative model of others are categorized as dismissing while those who have a negative model of self but a positive model of others are categorized as preoccupied.

Brennan, Clark and Shaver (1998) elucidated another widely used dimensional means of measuring attachment. They have defined attachment behavior in terms of anxiety and avoidance, referring to one's tendency to fear abandonment or to have trouble connecting with others respectively. These dimensions could be used in tandem to create attachment categories akin to those of Bartholomew and Horowitz (1991). Those high in both anxiety and avoidance have been labeled disorganized while persons low in both are secure. Persons high in anxiety but low in avoidance are considered anxious-ambivalent while those low in anxiety but high in avoidance are considered avoidant. I utilized Brennan, Clark and Shaver's conceptualization of attachment for the present study and their assessment, the Experiences in Close Relationships – Revised (ECR-R; Fraley, Waller & Brennan, 2000), as Ravitz and colleagues (2009) have noted strong psychometrics and stated this assessment has been widely used in the measurement of romantic attachment and in studying "the link of attachment with appraisal of social support" (Ravitz et al., 2009, p. 427).

Significance of Attachment to Biological Health and Pain

Researchers have suggested attachment insecurity relates to greater risk for health issues. For instance, McWilliams and Bailey (2010) noted from their analysis of data from the National Comorbidity Survey Replication (NCS-R) that about half of the 15 health conditions they investigated were associated with insecure attachment, particularly attachment anxiety (N=

5,645). Attachment anxiety was significantly associated with back and neck pain, headaches, other chronic pain conditions (besides arthritis, back or neck problems or headache), stroke, high blood pressure and ulcers while avoidant attachment was associated only with back and neck pain, headaches and other chronic pain conditions. When the authors factored out history of psychiatric disorder for pain conditions, however, only the association between anxious attachment and other forms of chronic pain remained significant. They suggested psychopathology may mediate the relationship between attachment and health issues such as pain.

Speaking more directly to chronic pain conditions, Forsythe and colleagues (2012) noted attachment processes may be activated by pain and may influence how one responds to it, as pain can represent a threat to one's well-being. Describing theoretical perspectives of pain based in attachment, Meredith and colleagues (2008) noted those with attachment insecurity are considered more likely to have worse outcomes over a variety of interventions and to have problematic adjustment to their pain conditions. For instance, those with insecure attachment are seen as being at greater risk of chronic pain, less capable when it comes to managing their pain-related distress, finding it more difficult to solicit and obtain social support and perceiving their health professionals as not acting in their best interests. Thus, attachment may influence chronic pain and health states more broadly, but further research is required to better understand why individuals with attachment insecurity may be more vulnerable to these issues.

Empathy for Pain

In one example of the connection between attachment and adjustment to pain, recent literature has suggested that attachment and empathy for pain may influence pain perception (Hurter et al., 2014; Sambo et al, 2010). Sambo and colleagues (2010) investigated how

participants (20 female and 10 male) responded to heat pain stimulated by a thermal probe on the participant's forearm when in the presence of unfamiliar observers who communicated numeric ratings of empathy that were high or low or when they were alone. These authors found higher attachment anxiety predicted lower self-report of pain when in the high empathy condition compared to the low empathy condition. Attachment avoidance predicted lower self-report of pain when alone than when with an observer regardless of empathy condition. Sambo and colleagues offered, then, that those higher in attachment anxiety experienced lower pain with high empathy because they doubt the support of others and benefit from such reassurance. Those higher in avoidance may alternatively experience greater pain report when in the presence of others because of a preference for solitary coping.

Hurter and colleagues (2014) engaged in a similar investigation but with somewhat conflicting results. Participants were couples (28 females, 26 males) in three attachment styles (avoidant, anxious or secure) subjected to two manipulations (low or high empathy) while undergoing a cold pressor task. One participant from the couple was asked to submerge a hand in water maintained at 2 to 4° C to stimulate pain while being given a manipulated empathy rating from the researcher that was either high (8) or low (2) on a scale of 0 (no empathy) to 10 (most empathy), which participants were led to believe came from their partner. The authors observed greater pain report in the high rather than the low empathy condition. They noted, though, that avoidant individuals reported less pain during the high empathy condition compared with anxious and secure groups. They suggested pain salience may account for differing patterns of pain report, describing that such salience may be dependent on trust for one's partner. Hurter and colleagues proposed that greater empathy for pain will be perceived by anxious and secure

individuals who trust their partners as a cue for pain salience while avoidant individuals who have less trust for their partners will not perceive their pain to be more salient.

A later study by Krahe and colleagues (2015) supported Sambo and colleagues' (2010) assertion that those with avoidant attachment prefer solitary coping. These writers used laser-evoked potentials (LEP), where painful stimuli are delivered by laser and time-locked to EEG data in order to analyze participants' neurophysiological response. Thirty-nine female participants were asked to rate their pain in response to laser emissions of varying intensity under three conditions: one in which their partner rated his empathy for the participant while in the room with the participant (partner focus), one in which the partner rated his empathy for another participant while in the room with the participant (other focus), and finally a condition in which the partner rated his empathy for another participant while in another room away from the participant (partner absence). These investigators found attachment avoidance was positively associated with greater N2 and P2 amplitudes, or the negative and positive going waves in the EEG data occurring approximately 200ms after stimulus onset, suggestive of the "conscious experience or 'perceptual outcome' of the sensory experience" of pain when the partner was present compared with when the partner was absent (Krahe et al., 2015, p. 2). Thus, avoidant individuals experienced greater distress when with their partner than when alone.

Empathy appears to influence pain perception differently for persons with different attachment configurations. Attachment avoidance appears to relate to lower pain report (Sambo et al., 2010) and lower neurological reactivity (Krahe et al., 2015) when alone, than when supported by others, and may be uninfluenced by empathy manipulations (Hurter et al., 2014) suggestive of a general preference to cope alone. The relationship between attachment anxiety and pain perception is less established, as Sambo and colleagues noted lower pain report with

greater empathy, while Hurter and colleagues noted the opposite. It is possible this discrepancy is due to Sambo and colleagues having used unfamiliar observers while Hurter and colleagues used participant's partners for empathy manipulations because support in these contexts may function differently; a notion which future researchers should carefully consider.

The Influence of Gender on Reception of Social Support for Pain

While considering how attachment may influence the reception of empathy or social support, it may also be important to account for the influence of gender. Chambers and colleagues (2002), for instance, noted from their study of sex, maternal support and cold pressor pain among children that girls' pain ratings were influenced by pain reducing or pain promoting language from their mothers, reporting lower or higher pain ratings respectively compared to one another and a control group, while boys were unaffected.

Jackson and colleagues (2005) studied the influence of interpersonal transactions among adult men and women exposed to cold pressor pain. They found that relative to a no transaction condition where participants could not talk to a researcher in the room while undergoing their pain trial, those who had the opportunity to speak with the researcher reported greater pain, and demonstrated more emotional support seeking and catastrophizing and ignored their pain less. They noted, however, that there was no gender difference in these outcome variables in either condition. In a follow up study, however, the researchers found women demonstrated greater pain tolerance when distracted by a researcher, were guided in reinterpreting their pain or provided encouragement and support, while no such effect was visible for men.

Gender-related expectations for pain, then, may influence how individuals respond to pain. For example, Robinson and colleagues (2001) noted from their research that both women and men reported believing men were less willing to report their pain and this sex effect

accounted for 46% of the variance (Robinson et al, 2001, p. 254). These writers have suggested there is a response cost for men to report pain in experimental studies as it contradicts a stereotypically tough gender role. As such, they proposed men may appear more stoic and demonstrate higher pain threshold and tolerance to avoid embarrassment or anxiety resulting from acting in a manner that is not consistent with a stereotypical masculine response. In contrast, they noted relatively small differences are observed between sexes in chronic pain studies, possibly because this male response cost may be lower as report of pain is integral to receiving appropriate medical care.

It is possible that one may make more sense out of how gender influences pain experience if considered together with attachment. Fillingim and colleagues (2009) noted men and women have demonstrated differences in coping with clinical and experimental pain, and several recent studies have demonstrated differing dimensions of attachment may be more or less important for relationship outcomes for different sexes (Collins & Read, 1990; Consedine & Fiori, 2009; Monteoliva et al., 2012). Research has suggested attachment anxiety may be more predictive of relationship outcomes for women (Collins & Read, 1990; Consedine & Fiori, 2009) while attachment avoidance may be more predictive of such outcomes for men (Collins & Read; Monteoliva et al., 2012). Hence, it is worthy of considering whether different dimensions of attachment may be more important for particular genders in influencing pain experience and adjustment insofar as attachment characteristics may influence the ability of someone to access and use available social supports.

Social Baseline Theory

Coan's (2008) Social Baseline Theory (SBT) may be helpful in conceptualizing how attachment relates to adjustment to chronic stressors such as pain. Unlike animals who have

evolved adaptations for existing in specific physical environments, Beckes and Coan (2010) have advocated that the dominant ecology of humans is other humans. It is difficult to conceptualize how neural processes account for attachment relations, however. As Coan (2010) has noted, the attachment behaviors described by Bowlby may not be so tightly organized within the brain as they are in his model. Indeed, attachment relations appear to rely on dopaminergic projections through the brain in areas associated with such disparate processes as reward and punishment. Moreover, psychophysiological attachment processes are also influenced by neuropeptides like oxytocin and vasopressin. As such, Coan has argued that the brain itself is an attachment system.

Coan (2008) has conceptualized attachment as a neural construct using bioenergetics. Consistent with Proffitt (2006), Coan has noted that in order to survive, one must take in more energy than one expends. Some of the costliest metabolic resources are those related to emotional regulation in the frontal cortex. As such, Coan asserted people are motivated to avoid bioenergetically expensive processes like emotional regulation whenever possible.

Coan (2008) has advocated individuals avoid expending excessive energy by making bioenergetic bets on the environment deciding "at any given time about what resources to deploy, and at what level of effort" (Coan, 2008, p. 17). He noted the research of Proffitt (2006) who described that persons who are wearing a heavy backpack estimate the incline of hills to be greater than those who are not. The mind is thus capable of changing the odds of the bet by altering one's perception of the environment to discourage expending resources beyond one's means.

Coan (2008) has described two ways by which attachment influences one's perceptions of the environment. First, he noted *risk distribution*, a process similar to that described by Bowlby (1973) whereby one views the environment as being safer when with others because

danger to any one person is statistically reduced. Secondly, he described *load sharing*, wherein a couple that are bonded together share the demands of emotional regulation. This happens through an on-line process as one partner may soothe another who is sad, or in the form of attachment representations internalized by the individual as a result of their bond.

While Coan (2008) asserted secure persons make good bets in response to attachment situations, he noted that persons of insecure attachment styles may make poor bets with regards to their resources. Such persons may utilize more cognitive resources than necessary, continuing to perceive their environment as threatening and to engage in emotional control strategies even when supported by others.

This theory has been supported by several recent neuroimaging studies. Coan and colleagues (2013) reanalyzed data from 16 married women gathered with functional magnetic resonance imaging (fMRI) exploring how mutuality between spouses influences neural reactivity to visual cues indicating safety or threat of electric shock. They described mutuality as one's interest in the experiences and perceptions of the partner and willingness to share one's own experiences and perceptions. Whereas in the original study, Coan and colleagues (2006) found that whether women held the hand of a spouse or stranger, or were alone influenced brain activity during this task, Coan and colleagues (2013) noted that when they controlled for mutuality, the previous handholding effect disappeared. They discovered that *other mutuality*, referring to the woman's sense that her partner was there for her and interested in her experiences, explained reduction in emotional regulation resources, particularly in the dorsolateral prefrontal Cortex (dlPFC). They noted this may signify women who experienced greater mutuality with their spouses generally perceived their environments to be less threatening even when their spouse is not present.

Johnson and colleagues (2013) examined SBT in the context of couple's therapy. Female partners of 23 couples were studied with fMRI while observing visual cues for safety or electrical shock when holding the hand of a spouse, stranger or being alone, before and after they went through sessions of Emotion-Focused Couples Therapy (EFT) with their spouse. Consistent with Coan and colleagues (2013) reduction in dlPFC activity was only significantly seen with spousal handholding. Johnson and colleagues (2013) noted that this may be evidence of *load sharing*. They suggested the observed reduction in dlPFC activity may relate to a reduction in threat perception as it is shared with the partner.

In distressed couples that experienced greater self-regulation during stranger handholding, the authors theorized this finding may relate to *risk distribution* (Johnson et al., 2013). Consistent with Coan (2008), being with a stranger may have promoted regulation through "safety in numbers" (Johnson et al., 2013, p. 8). In support of this, they found less activity in the ventral portions of the ACC and the Periaqueductal Gray, which are implicated in perception of "acute arousal and defensive motor planning" (Johnson et al., 2013, p. 8).

In conclusion, consistent with SBT, attachment likely influences emotional regulation by adjusting perception of threat within the environment (Coan, 2008). This adjustment of perceived threat appears to occur by way of altered patterns of metabolic activity in a variety of brain regions according to the source of that social support. Social support from a close other appears to influence threat perception through diminishing the need for metabolically costly emotional control strategies, while social presence of unfamiliar others may more likely reduce one's perceived need to mobilize self-preservative, fight-or-flight resources.

Event-Related Potentials (ERP) and the P300

Given that I utilized the event-related potentials technique to measure P300 amplitudes of participants it would benefit further discussion to address the nature of this methodology. Luck (2005) has noted electroencephalography (EEG) was created by Hans Berger in 1929. Berger amplified the electrical signals in the brain from the scalp and plotted their voltage over time. ERP is an elaboration of EEG wherein electrical activity of the brain is time-locked to a particular stimulus event so that one's reaction can be observed down to the millisecond. Any recording of neural activity is assumed to contain desirable data but also noise (Luck, 2005). Thus, brain activity for stimuli of interest is averaged at each electrode site for individual participants in order to maximize measurement of the data of interest while minimizing noise. This results in a waveform for individual participants at each electrode site that is then grand-averaged together across participants. Components within any waveform are delineated in terms of their positive (P) or negative-going (N) peaks or successive up and down deflections as the waveform progresses through time and by their order, such that P1, N1, P2, N2, and P3 refer to the positive or negative valence of the component and its place within that waveform (Luck, 2005).

Polich (2007) noted the P3 component, sometimes referred to as the P300, is composed of a P3a and a P3b, though most P3 research refers to the P3b. The P3a appears to be dopaminergic and frontal and is elicited in response to surprising stimuli, while the P3b appears to be noradrenergic and located in more temporal and parietal regions of the brain, being elicited by the presentation of stimuli that one is to search for out of a sequence of other stimuli. Components are often described in terms of their amplitude, which is measured by subtracting the baseline electrical value from the highest peak within a specific window of time (Polich, 2007). According to Mark, Guerdes and Becker (2012), with regards to emotional stimuli,

greater P300 amplitudes are thought to "suggest that these stimuli are processed more deeply or fully in some way" (p. 130).

One of the most common ways that the P3b is elicited is through the oddball paradigm (Polich, 2007). In the oddball paradigm, one is asked to seek out a less frequent target stimuli from a sequence of more frequent standard stimuli, often indicating observation with a button-press. Polich has suggested the oddball paradigm to be a reliable clinical assay, and stated test-retest reliability for P3b amplitude in oddball experiments tends to range between 0.5 and 0.8.

ERP, Threat and Emotional Adjustment

Several recent studies have emerged to investigate the relationship between the P300 and threatening or negative content. Mark, Guerdes and Becker (2012) used a sample of 25 neurologically healthy female students to study how attachment anxiety and avoidance related to approach-avoidance behaviors indexed by the N100/P200 and P300 components of ERP while completing four oddball tasks. Polich (2007) has noted that in the standard two-stimulus oddball task, participants are presented with two stimuli and asked to pick out the rare target stimulus from among another frequent stimulus. In Mark and colleagues four two-stimulus oddball tasks, participants were instructed to pick out angry target faces among frequent neutral faces and vice versa, as well as fearful target faces among neutral frequents and vice versa. The authors also attempted to understand how personality traits like autonomy, along with anxiety and depression, influenced participants' attention to the target faces.

The authors found only a significant effect for the P300 component in the task where pictures of angry faces were targets among neutral-faced frequents (Mark, Guerdes & Becker, 2012). They found no significant effect for hemisphere, though they only reported significant findings for the P300 amplitude in electrode sites F3 and Cz. They learned that P300 amplitude

was related to attachment anxiety, and women who had greater attachment anxiety demonstrated greater P300 amplitudes for the angry pictures. After controlling for anxiety, the relationships previously found between secure and anxious attachment and the N100 (related to attentional processing) component were no longer significant, while the P300 remained positively associated with anxious attachment at F3 and now Fz electrode sites and negatively associated to secure attachment at F3. When controlling for anxiety, the difference in P300 amplitude between angry and neutral face trials at Cz was no longer significant.

The authors noted they expected to find that those high on attachment anxiety would develop an approach/avoidance behavioral pattern characterized by greater initial N100 (again related to attentional processing) and P200 (related to discrimination of stimuli) amplitudes and lesser P300 amplitudes while avoidant attachment would be related to an overall flattened waveform for the N100 and P300, indicative of avoidance. In contrast, they found no effect for attachment avoidance and the opposite effect for attachment anxiety. Greater degrees of attachment anxiety related to lower N100 amplitudes and higher P300 amplitudes. Greater degrees of attachment security related to higher N100 and lower P300 amplitudes. While these results did not support classical approach/avoidance theories of anxiety, they may be more easily explicable by way of Coan's (2008) SBT. This writer would suggest that consistent with SBT, individuals who are higher in attachment anxiety may continue to regard their environment as threatening and negative even when they are supported, and so perseverate on negative stimuli. Instead, secure persons may carry internal representations of their support such that they regard the environment as less threatening and requiring of less attention than anxiously attached persons.

A recent study by Bistricky, Atchley, Ingraham and O'Hare (2014) may suggest a relationship between attention to negative stimuli and more long-term psychopathology. They studied the responses of 55 undergraduate participants (50-71% female depending on depressive group) to an oddball paradigm where they were instructed to push a button in response to sad faces among neutral standard faces. They noted that persons with some depression history demonstrated greater P300 amplitudes in response to sad faces than persons who were never depressed, even if they were not currently depressed. As such, perseveration on negative content may be predictive of depression.

The Present Study

Study Purpose

In the present study, I examined how women's attachment anxiety influenced perceptions of social support from others in the context of empathy for pain. Forsythe and colleagues (2012) noted from their survey study of chronic pain patients that while both preoccupied (roughly equivalent to the anxious-ambivalent style) and secure attachment were associated with increased self-report of pain behaviors in the context of perceived negative spousal response to pain behaviors, only preoccupied attachment was associated with endorsing more depressive symptoms. Given that attachment anxiety appears to influence allocation of attentional resources to threatening images (Mark et al., 2012) it is worth investigating whether attachment influences adjustment to illness by way of coloring one's perception of partner support. I will focus on women in the present analysis because past researchers have found that women's pain perception is more susceptible to the influence of support than men's pain perception (Chambers et al., 2002; Jackson et al., 2005). Moreover, insofar as the works of Mark and colleagues and Forsythe and colleagues have demonstrated that attachment anxiety may influence pain coping, and

attachment anxiety is more predictive of relationship outcomes among women than men (Collins & Read, 1990; Consedine & Fiori, 2009) it would seem ideal to begin studying how empathy influences the allocation of attentional resources in the context of threat using women with attachment anxiety.

I studied, then, how attachment and social support for pain influenced perception of social support by examining how empathy for pain from a perceived unfamiliar observer interacts with participants' attachment anxiety to influence P300 amplitude for angry face pictures. Female participants were dichotomized into high or low attachment anxiety groups. After completing a cold bottle pain stimulation procedure, these individuals were then given a high or low empathy rating assigned by the researcher but presumed to come from an unfamiliar male observer watching from another room. Participants then underwent a visual oddball task, where they are asked to push a button when seeing rare angry-faced target pictures among more frequent neutral-faced pictures. Greater P300 amplitude for angry-faced pictures was interpreted to suggest greater allocation of attentional resources.

Hypotheses

H1: I hypothesized that there would be an interaction effect for empathy condition and attachment anxiety, such that empathy condition would influence the P300 component for angry-faced images in a different manner for high and low attachment anxiety participants. This effect would be more prominently lateralized to the left hemisphere.

Rationale: While no past research has directly demonstrated that empathy and attachment anxiety influence attention to threatening images, several studies have supported the notion that empathy and attachment anxiety influence perception of threatening constructs such as pain (e.g. Hurter et al., 2014; Sambo et al., 2010). Further, Coan (2008) has suggested that attachment is

capable of modulating amygdalar threat response in a top-down manner and that the amygdala is "exquisitely sensitive to social signals expressed in the face" (Coan, 2008, p. 6). Since Coan has suggested attachment constructs are capable of modulating threat perception, I hypothesized that expressions of social proximity by communication of empathy for pain would interact with attachment anxiety to influence participants' felt need to attend to threatening stimuli.

The notion that this effect would be lateralized to the left hemisphere is founded on both empirical observation and theory. While Mark and colleagues (2012) did not discover a lateralized effect for their faces paradigm, the only electrode site which demonstrated a stable P300 effect for angry-faced images was the left-frontal electrode, F3. In contrast, the analogous right electrode, F4, did not demonstrate an effect. Additionally, Coan (2008) has noted that a left lateralized effect in the prefrontal cortex is associated with approach behaviors like anger and joy, while right lateralization is associated with avoidance behaviors like sadness and fear. Ainsworth and Bell (1970), in their early infant studies, noted that approach and exploration behaviors were facilitated by the presence of the object of attachment, while fear and avoidance behaviors were more likely in the absence of such figure. It is well to note in this study that I did not use an "empathy" versus a "no empathy" condition but rather a "high" versus a "low empathy" condition. All participants received some degree of empathic support and therefore communication of social proximity. Accordingly, since both conditions offered different degrees of "presence" for a simulated attachment figure, I presume whether that support is high or low will influence the participant's basic approach and exploration responses, and therefore their left-lateralized prefrontal brain activity.

H2: I hypothesized that those participants with high attachment anxiety who were exposed to low empathy would have a greater P300 amplitude for angry-faced images in comparison to participants with high attachment anxiety who were exposed to high empathy.

Rationale: While Sambo and colleagues (2010) and Hurter and colleagues (2014) performed studies which similarly investigated how empathy influences perception of pain intensity, they demonstrated differing patterns of results. Sambo and colleagues suggested that pain report was lower when individuals had higher attachment anxiety and were given greater empathy ratings compared to lower empathy ratings because they benefitted from the reassurance. On the other hand, Hurter and colleagues suggested that both secure and anxiously attached persons reported greater pain intensity when given greater expressions of partner empathy because that empathy communicated pain salience and therefore a need to attend to their pain. As aforementioned, there may be a variety of reasons for such differences. For example, Sambo and colleagues' use of unfamiliar observers in contrast to Hurter and colleagues who used romantic partners, and the studies measured attachment anxiety differently from one another.

Given this study utilized simulated unfamiliar observers to provide empathy ratings, I predicted participants would be more likely to react to the empathy manipulation, consistent with the findings of Sambo and colleagues. I suggested, then, that persons with greater attachment anxiety would benefit from greater empathic support, demonstrating lower P300 amplitudes for angry pictures when being given greater empathy (as compared to lower empathy). I surmised this effect would be due to persons with greater insecurity measured by attachment anxiety having a weaker internalized schema of support, as compared to securely attached persons (Mikulincer, Shaver & Dolev, 2004).

H3: I hypothesized that no group differences would be found by empathy category for the P300 amplitudes for angry-faced images among low attachment anxiety participants.

Rationale: While Coan and colleagues (2013) did not investigate how attachment related to brain activation for cues threatening electric shock, they suggested perception of positive partner support related to less threat-related neural activation whether or not that partner was physically with the participant. Taken together with the view that attachment is trait-like (Bowlby, 1977) and more broadly influences the decisions one makes regarding how to use resources in guarding oneself from threat (Coan, 2008), and because securely attached persons may have gained that "security from internalized representations of security-enhancing attachment figures without necessarily causing a person to actually seek proximity to these figures" (Mikulincer & Shaver, 2003, p. 75), it is possible that persons who are more securely attached may direct fewer attentional resources to threatening pictures regardless of empathy expressed by a stranger.

H4: I hypothesized that high attachment anxiety participants would have higher P300 amplitudes for angry-faced images than low attachment anxiety participants, when empathy condition was not regarded.

Rationale: Mark and colleagues (2012) demonstrated greater P300 amplitudes with greater attachment anxiety for their visual discrimination task where angry pictures were rare targets among a background of more frequent neutral-faced images for female participants. Bowlby (1977) again described attachment as taking on a trait-like characteristic, and in the context of Coan's (2008) SBT, women may be expected to expend more effort on monitoring threats within their environment if they are insecurely attached. Moreover, as attachment anxiety may have a greater impact on relational outcomes for women (Collins & Read, 1990; Consedine

& Fiori, 2009), one may expect that attachment anxiety specifically will differentiate attentional response for females.

Methods

Participants

Several inclusion and exclusion criteria are notable for this study. Given that this study used a cold bottle task similar to cold pressor methodology, participants with Raynaud's Disease, cold urticaria, aneurysm, and a history of cardiovascular illness, diabetes, chronic rheumatologic disease or any untreated blood pressure abnormalities were not allowed to participate ($N = 7$), consistent with the recommendations of Porcelli (2014). Moreover, participants who had any other condition which would make the cold pressor or visual discrimination task unsafe (e.g., seizure disorder or neurocardiogenic syncope) were excluded ($N = 9$), as well as any persons who had conditions which could pose a risk to other participants or researchers (ex. skin-borne infectious disease) ($N = 2$). Additionally, participation was restricted to women who were between the ages of 18-30 years old. As a result, participants identifying as male ($N = 14$) or who were outside of the age range ($N = 2$) were excluded. Finally, consistent with the procedure of Hurter and colleagues (2014), participants were included only if they scored in the 40th percentile or below (scores of 3.273 or below) or 60th percentile or above (scores of 3.846 or above) on the attachment anxiety scale of the Experiences in Close Relationships – Revised, as compared with the dataset of Fraley, Waller and Brennan (2000). As such, participants with attachment anxiety scores in the median range were also excluded from the present study ($N = 23$).

A total of 170 students completed the prescreening survey and qualified for participation. Of these, students from each attachment anxiety category were invited to participate in the main study in the order they were received until 24 participants from high and low attachment anxiety

groups completed the full study, resulting in an initial sample of 48 participants. Due to technical issues such as failure to record (*N =3)* or problems with data quality (*N* = 6), 9 participants were subsequently excluded. Additionally, two invited participants were excluded and did not have their EEG data recorded; one due to having a hairstyle which was not conducive to recording with the EEG electrodes, while the other did not consent to the procedure after presenting to the lab.

As a result, 39 college-aged females (M_{age} = 21 years, *SD* = 1.20) were included in this analysis. Such sample sizes are common in ERP experiments and Mark, Guerdes and Becker (2012) have noted most ERP studies have fewer than 16 participants. In the high attachment anxiety group were 19 women, 11 who were in the high empathy condition and 8 who were in the low empathy condition. In the low attachment anxiety group were 20 women, 10 each in the high and low empathy conditions. Participants in the present study were mostly Caucasian (87.2%) followed by African American (5.1%), Hispanic or Latino/a, Asian and Native American (2.6% in each of these 3 categories). With regards to relationship status, participants identified as mostly single (53.8%). The majority of participants identified as Heterosexual (79.5%), followed by Bisexual (7.7%) and "Other" (eg. "Pansexual"; 5.1%). Several students did not report their sexual orientation (7.7%).

Measures

Experiences in Close Relationships – Revised. The Experiences in Close Relationships-Revised (ECR-R) is a 36-item questionnaire assessing attachment to romantic partners (Fraley, Waller & Brennan, 2000). The ECR-R is made up of two 18-item scales assessing attachment anxiety and attachment avoidance. Participants respond to items (eg. "I prefer not to show a partner how I feel deep down") on a 7-point Likert-type scale from 1 (Strongly Disagree) to 7

(Strongly Agree) with several items being reverse scored (Fraley, 2012). According to Fraley, scores for each scale are averaged together to produce a composite score for attachment anxiety and avoidance. Lower scores correspond to less anxiety and avoidance (Fraley, 2012).

Sibley, Fischer and Liu (2005) assessed the reliability and validity of this measure across three studies. In the first study of three hundred undergraduate students (67% female), ECR-R anxiety and avoidance scales were found to be strongly positively correlated (r = .48) (Sibley et al., 2005). Moreover, ECR-R measures of anxiety and avoidance were correlated moderately positively with the anxiety (r = .60) and avoidance (r = .62) measures of another attachment measure, the Relationship Questionnaire (RQ).

The authors used exploratory factor analysis to demonstrate a two-factor solution for the ECR-R and RQ explaining 48% of the variance between scales (Sibley et al., 2005). Items for the avoidance measure of the ECR-R and RQ loaded onto the first factor, while items from the anxiety measure of the ECR-R and RQ loaded onto the second factor. The authors then demonstrated that the ECR-R and RQ likely measure the same attachment dimensions of anxiety and avoidance by creating composite scores for these four measures and submitting them to exploratory factor analysis yielding two factors accounting for 83% of the variance. They reported that composite anxiety measures for the ECR-R and RQ loaded onto the first factor and composite avoidance measures for these scales loaded on the second factor.

Sibley and colleagues (2005) also demonstrated good stability for the ECR-R. The ECR-R and RQ were administered at two time-points three weeks apart. They noted that measures of attachment anxiety and avoidance administered at Time 1 loaded on to the appropriate Time 2 measures. Indices of fit were suggestive of acceptable fit of this model for the data. These authors examined a second model in which latent ECR-R attachment anxiety and avoidance at

Time 1 loaded onto Time 2 RQ measures of anxiety and avoidance respectively, predicting "5% and 6% of the variance in their respective RQ measures in addition to that already predicted by the RQ at Time 1" with excellent fit of the model to the data (Sibley et al., 2005, p. 1528).

In their second study of 458 undergraduate students (70% female), Sibley and colleagues (2005) used confirmatory factor analysis (CFA) to scrutinize the ECR-R. These authors again discovered that anxiety and avoidance measures of the ECR-R loaded onto separate factors and produced a model that fit the data excellently.

Finally, in their third study of 82 undergraduate students (74% female), these authors examined validity further by investigating agreement between the ECR-R and analysis of a social interaction diary (Sibley and colleagues, 2005). These researchers suggested that the ECR-R predicted "sizable portions of the variance in respective diary ratings of anxiety and avoidance experienced during social interactions with a romantic partner" but only weakly related to anxiety and avoidance diary ratings for a close friend or family member (Sibley et al., 2005, p. 1533). They also suggested that "the ECR-R predicted more than twice as much variance in avoidance, anxiety, and enjoyment in social interactions with a romantic partner as it did variance in interactions with a family member and more than 3 to 4 times as much variance as it did in interactions with a platonic friend" (Sibley et al., 2005, p. 1533).

Overall, the ECR-R is a reliable and valid measure for assessing romantic attachment among a college-aged population. Sibley and colleagues (2005) have described the assessment as preferable among other attachment measures when one is investigating either "subtle attachment effects with limited power or relatively small expected effect sizes and/or […] analyses or designs that may exacerbate potential measurement error" (Sibley et al., 2005, p. 1534). Given that the present study is subject to a restricted sample size of 39 participants due to the time-

consuming and laborious nature of ERP research, the ECR-R was an appropriate measure to maximize observed attachment effects.

Equipment

EEG data was collected with an ActiveTWO system from BioSemi (BioSemi, Amsterdam, The Netherlands). Participants were fitted with a cloth cap into which 64 pin-type sodium chloride electrodes were placed using the 10-20 system. Electrical potentials from facial muscles were recorded with electrooculography (EOG) by placing two flat-type electrodes on the participants face, one below the right eye and the other to the right of the right eye. The data was referenced to two flat-type electrodes placed over the mastoids. A ground was formed by using the Common Mode Sense (CMS) and Driven Right Leg (DRL) electrodes which create a feedback loop bringing the participant's average potential close to the reference voltage for the data collection device ("What is the function," n.d.).

Data was originally collected using ActiView data capture software (BioSemi) at a sampling rate of 2048hz. It was then resampled to 512hz for data analysis. It was low pass filtered at 55 hz and high pass filtered at 0.5 hz offline to remove ambient electrical potentials from the environment and muscle potentials in EEGLAB (Delorne & Makeig, 2004). Next, the data was visually analyzed to reject artifacts related to muscle tension and line noise. The continuous EEG data was then segmented into 1200ms epochs including 200ms pre- and 1000ms post-stimulus onset. Bad channels were removed and independent component analysis (ICA) was used to "detect and remove stereotyped eye, muscle, and line noise artifacts" (Delorne & Makeig, 2004, p. 4-5). ICA utilizes algorithms to isolate neutrally generated and artefactual EEG sources (Delorne & Makeig, 2004). Bad channels were interpolated, and event-related potentials were grand-averaged for trials.

Participants were presented with a visual discrimination oddball task designed in E-Prime (Version 2.0; Schneider, Eschman & Zuccolotto, 2002). A PropScope oscilloscope was used to verify that visual stimuli were presented to the participant simultaneous with the trigger codes corresponding to those stimuli received in the EEG data. Participants submitted their responses to the visual stimuli by depressing a button on a Cedrus RB-530 button box. Visual stimuli were presented at a refresh rate of 60 hz on a monitor with a resolution of 1920 x 1080 pixels.

Cold Bottle Task

Participants engaged in a cold bottle task researched by Chen, Chang and Arendt-Nielsen (2000). These writers studied their procedure with 15 healthy male participants between the ages of 22- and 26-years-old. These writers designed this task to study pain perception with EEG, noting the drawbacks of traditional cold pressor tasks being that sensitive EEG measurements could be confounded by heightened blood pressure, withdrawal responses that are motoric in nature or muscle tension more generally. These authors asked participants to rate their pain on a scale of 0 to 10 every 15-seconds for a period of three minutes while holding bottles cooled to -10° Celsius, 5° Celsius and room temperature. They noted that "mean peak-plateau intensity over the 7 level (strong pain)" occurred after 60 seconds and was reduced to mild pain (5/10) after 90 seconds for the -10° bottles. They noted no pain effects for the 5° Celsius and room temperature bottles.

Empathy Conditions

In similar form to Sambo and colleagues (2010) and Hurter and colleagues (2014) I introduced an empathy manipulation to participants. A researcher told the participant that part of the study is about understanding how men empathize with the pain of another person. Accordingly, the researcher told the participant that a male student will be present to watch her

pain task from another room and fill out an empathy questionnaire. In reality, no male research participant rated his empathy for the female participant's pain. To maintain the plausibility of the absence of a physical observer, the participant was told that she was prevented from seeing the male participant until after the study was over in order that the male participant's appearance would not affect how she received his empathy rating.

The empathy manipulation was delivered in a similar fashion to Hurter and colleagues (2014). Participants perceived this empathy rating to represent how much the observers "understand and share the feelings" of the participant (Hurter et al., 2014). Empathy ratings were given on a scale of "0" to "10" with "0" being lowest and "10" being highest. Participants were given a score of "2" by the researcher in the low empathy condition and "8" in the high empathy condition. Participant were assigned to either the high or low empathy condition and this empathy rating was presented to the participant on the computer screen in front of them before the experimental task began.

Construction of the Visual Discrimination Threat Task

I used a visual discrimination task similar to Mark and colleagues (2012) to measure attentional allocation to negative social stimuli. Because participants were told that a male research participant would be observing their pain trial, male pictures populated the visual discrimination task. Angry and neutral faced pictures were derived from the Karolinska Directed Emotional Faces (KDEF) database (Ludqvist, Flykt & Ohman, 1998). The database is composed of 70 individuals (35 men and 35 women) displaying seven emotions. The emotions displayed by the study models were anger, disgust, fear, sadness, happiness, a neutral expression and surprise. Study models were photographed twice from five different angles for each expression. The first

and second photographing resulted in an A and B series (Goeleven, De Rædt, Leyman and Verschuere (2008).

Goeleven and colleagues (2008) attempted a validation of select pictures from the KDEF database. They focused on 490 pictures from the A series with a frontal view of the model and cropped the hairline from the pictures to "minimize fashion issues" (Goeleven, et al., 2008, p. 1096). The authors used a sample of 272 female students from Ghent University for this study with a mean age of 21.1 years (SD = 2.1). These women were instructed to rate pictures on emotion, intensity and arousal. To rate emotion, participants were asked to circle one of the six basic emotions, "neutral" or an indistinct option. To rate intensity, participants were presented with a 9-point Likert scale where "1" signified that the picture was "not at all" intense to "9" representing "completely" intense. Participants rated arousal by using the Self-Assessment Manikin scale, where they were to place an "x" on or between one of five graphical depictions ranging successively from "calm" to "aroused" resulting in a point value of "1" to "9". They reported that the mean success index for all pictures in the study was 71.87% (SD = 25.78). The biased hit rate (the percent of participants who correctly identified the emotion portrayed in the image) for angry pictures was 78.81% (SD = 22.89), while the average intensity was rated 5.59 (SD = 0.93) and the arousal was an average of 3.58 (SD = 0.53). For neutral pictures, the biased hit rate was 62.64% (SD = 23.77), while intensity was rated on average at 4.75 (SD = 0.50) and arousal at 2.67 (SD = 0.32). Goeleven and colleagues concluded that the hit rate observed in the study suggested that the DKEF database was a valid, extensive "and readily applicable stimuli set of human affective facial pictures" (2008, p. 1105).

The authors also performed a study of test-retest reliability using two groups of 21 female students (mean aged 20.7, SD = 1.9 and 20.1, SD = 1.5 respectively) who "rated each half of the

KDEF picture set at Time 1 and at Time 2 (one week later)" (Goeleven et al., 2008, p. 1101). Each group of women viewed "6 randomly selected slide shows [presented twice in the same order]" (Goeleven et al., 2008, p. 1101). They noted, however that approximately 87.96% of the emotion ratings (SD = 15.67) were the same from Time 1 to Time 2. Rated intensity at Time 1 had an average correlation of .75 (SD = 0.28) with rated intensity at Time 2 for the pictures while arousal had an average correlation of 0.78 (SD = 0.24).

I chose four male identities to supply the angry and neutral faced pictures for this study based on the hit rates reported by Goeleven and colleagues (2008). The hit rate for face images was the percent of participants who correctly identified the emotion portrayed in the image. These writers provided individual statistics for the 20 images with the best validity. Images M10AN, M05AN, and M11AN were the angry male pictures with the highest hit rate (100%) and M17AN was the angry male picture with the next highest hit rate (98.44%). As such, I utilized the angry and neutral faced pictures from these four male identities. In similar form to the study of Goeleven and colleagues, this writer cropped the hairline out of the images and ensured that each picture was of equal size.

Visual Discrimination Task Description. Participants were presented with these faces in a task designed in E-Prime (Version 2.0; Schneider, Eschman & Zuccolotto, 2002). A blank screen was presented with a fixation cross ('+') to direct participant's eyes to the center of the screen 250 milliseconds (ms) before stimulus onset. This cross was then replaced by an angry- or neutral-faced picture for 200 ms. Visual stimuli were followed by a delay of 600 to 800ms. Participants were asked to identify the angry faces by pressing a button. Following the oddball procedure of Mark and colleagues (2012), target stimuli were approximately 30% of the total

stimuli such that there were 100 target and 340 standard stimuli. Picton (1992) has noted that the P300 is typically measured with between 30 and 100 trials averaged together.

Procedure

Participants were solicited through the research pool of students in the Department of Counseling Psychology, Social Psychology and Counseling at Ball State University (N=32) or from the broader university community through the Ball State Communications Center (N=7). Interested participants were asked to complete a demographic questionnaire, along with the ECR-R online. Participants who completed the study and were students in Counseling Psychology courses earned credit toward course requirements. Those solicited through the Ball State Communications Center earned $10 per hour of study participation.

When participants arrived at the lab, they were shown the experiment room and a separate control room where the computers recording the EEG data are housed. They were then asked to sign the main study informed consent. After this, participants were seated in front of a computer screen and two researchers fit the participant with a cap and electrodes for EEG data collection.

Before participants began a practice task on the computer to acquaint them with the oddball visual discrimination task, they were told that another researcher had gone to retrieve a male student who would also participate in the study. Participants were informed that in order that the male participant's appearance did not bias how they received an empathy rating for their pain they would not meet that individual until the end of the study. The participant then completed the practice task composed of a shortened version of the main oddball task utilizing the same four angry- and neutral-faced male stimuli.

Next participants were told that the male research participant had arrived in the next room and was watching the participant through a passive video feed. Participants completed the cold bottle task, being asked to hold a glass bottle frozen to -10° C for 90 seconds, while being told that the male participant was observing them. They were informed that they could put the cold bottle down at any time and it was not necessary that participants held the cold bottle for the full 90 seconds. Participants were asked to rate their pain on a scale of 0 ("no pain") to 10 ("worst pain imaginable").

The participants were then notified that the male research participant had entered his empathy rating into the computer and were shown a falsified empathy rating before beginning the main oddball visual discrimination task. Empathy values were either high (8/10) or low (2/10). When the task was finished, the cap and electrodes were removed from the participant and they were debriefed regarding the study purpose and nature of the deception. As a manipulation check, a researcher would ask the participant if she believed the research confederate to be real during the study.

Validity Checks

I performed several validity checks with regards to the pain and empathy manipulations. Participants rated the pain intensity of the cold bottle task as mild (N = 37, M = 4.84, SD = 1.32). This is very similar to the pain ratings reported in Chen, Chang and Arendt-Nielsen's (2000) cold bottle study for holding the bottle at 90-seconds (5/10). With regards to the empathy manipulation, the majority of participants reported believing there was another participant rating his empathy for her pain from the other room (71.8%), followed by those who were unsure (17.9%) and those who reported that they did not (10.3%). When participants were finished with the study, they were told immediately about the empathy manipulation, to prevent them from

guessing whether the empathy-rating participant was real. All participants' data were analyzed regardless of their reported belief of the empathy manipulation as it is impossible to determine their honesty or the influence of hindsight bias.

Results

Assessment of Scalp Map

Based on the research of Mark, Guerdes and Becker (2012), I proposed that in the present study, an effect would be observed primarily over the frontal electrodes and more significantly lateralized to the left. In a similar oddball task, Mark and colleagues discovered that all ERP comparisons were more frontally distributed and greater attachment anxiety was related to greater P300 amplitudes for angry faces as measured at the F3 and Cz electrode site. When trait anxiety was partialed out, the P300 effect at Cz was no longer significant, though an effect at Fz subsequently became significant. Given that the significance of the effect at midline electrode sites was inconsistent, and Mark and colleagues demonstrated a stable effect at F3 which was not significant at F4, I proposed a frontal and left-lateralized distribution for the P300 effect.

After visually analyzing the components, I found the largest effect appeared to be present in the left frontal region as expected. After examining the scalp map, I calculated the grand average for eight electrodes in the frontal region including F3, F5, AF3 and AF7 in the left hemisphere and F4, F6, AF4 and AF8 in the right hemisphere. Based on the observed presentation of the P300 component, grand averages were computed between 350 and 650ms after stimulus presentation.

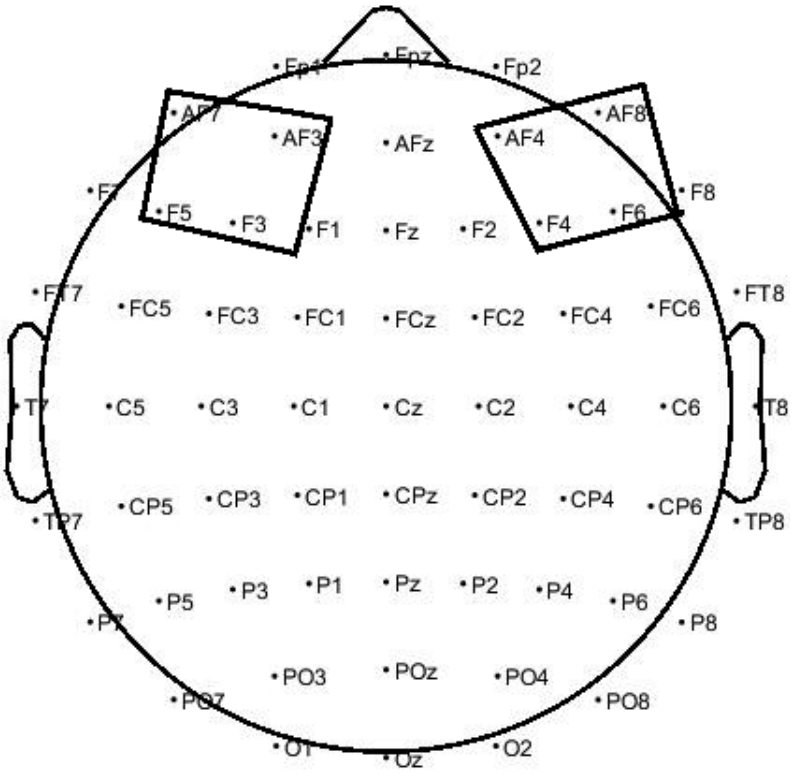

Figure 1. Scalp map depicting the locations of the left (F3, F5, AF3, AF7) and right (F4, F6, AF4, AF8) electrode clusters

Behavioral Data

Mean reaction time for the angry-faced images was 443ms. Participants were over 97% accurate in identifying the angry-faced images, and over 97% accurate in not identifying a neutral face as an angry face. Two-way ANOVAs were utilized to explore relationships between reaction time, accuracy for angry-faced images, and accuracy for neutral-faced images across attachment anxiety and empathy category groups, however there were no significant differences.

Hypotheses and Analyses

My first hypothesis was that there would be an interaction effect for empathy condition and attachment anxiety on the P300 component for angry-faced stimuli. I used a 2x2 ANOVA to assess for group differences by empathy condition (high or low) and attachment anxiety category

(high or low) for the P300 component for angry-faced stimuli averaged across both hemispheres. Levene's test was non-significant, suggesting sufficient equality of error variance. The results for the interaction effect were significant, $F(1, 35) = 6.72$, $p = .014$, $\eta_p^2 = .161$. Main effects for attachment anxiety category, $F(1, 35) = .031$, $p = .862$, $\eta_p^2 = .001$, and empathy condition, $F(1, 35) = .000$, $p = .986$, $\eta_p^2 = .000$, were both non-significant, however. The pattern of findings is suggestive of a crossover effect, whereby the influence of the empathy condition on the P300 amplitude is opposite for high and low anxiety participants (Table 1). Accordingly, this data supports my hypothesis that empathy condition and attachment anxiety would interact to exert a significant influence on P300 amplitude for angry-faced images.

Table 1
Mean P300 amplitudes for angry-faced images grand averaged bilaterally for attachment anxiety category by empathy condition

Attachment Anxiety Category	Empathy Condition	*M*	*SD*
High	High (*N*=11)	2.475	3.539
	Low (*N* = 8)	5.324	2.844
Low	High (*N* = 10)	5.114	4.049
	Low (*N* = 10)	2.304	2.819

I also suggested there would be a lateralized effect for empathy condition and attachment anxiety on the P300 component for angry-faced stimuli, such that there would be a larger effect for the left than for the right hemisphere. To test this hypothesis two-way ANOVAs were examined with attachment anxiety category and empathy conditions as between-subjects factors for the left and right P300 amplitudes for angry-faced images seperately. Again, Levene's Test was non-significant for either two-way ANOVA suggesting equality of error variances. For the left electrodes, the main effects of attachment anxiety category, $F(1, 35) = .000$, $p = .989$, $\eta_p^2 = .000$, and empathy condition, $F(1, 35) = .153$, $p = .698$, $\eta_p^2 = .004$, were not significant. These main effects were also not significant for the right electrodes for either attachment anxiety

category $F(1, 35) = .123$, $p = .728$, $\eta_p^2 = .004$, or empathy condition, $F(1, 35) = .121$, $p = .730$, $\eta_p^2 = .003$. The interaction effect was significant for both the right-clustered electrodes, $F(1, 35) = 4.305$, $p = .045$, $\eta_p^2 = .110$, and the left-clustered electrodes, $F(1, 35) = 9.057$, $p = .005$, $\eta_p^2 = .206$, however.

As a validity check, I investigated whether participants' reported belief that the unfamiliar observer was real influenced their P300 amplitudes for the angry faces with oneway ANOVA. Levene's test was non-significant. There was no significant difference in P300 amplitudes for the left-clustered electrodes, $F(1, 38) = 2.039$, $p = .145$, $\eta^2 = .102$. There was, however, a marginally significant difference in P300 amplitudes for the right-clustered electrodes, $F(1, 38) = 3.272$, $p = .049$, $\eta^2 = .154$. I then completed a post hoc analysis with Tukey's HSD for the right clustered electrode which revealed the significant difference to be between the group which said they did not believe the empathy manipulation ($N = 4$) and the group which said they were unsure ($N = 7$). Because there was no significant difference between either group and the group which did believe the empathy manipulation ($N = 28$), I consider this finding to be a statistical artifact.

In summary, empathy condition and attachment anxiety category again failed to exert significant individual influence on lateralized P300 amplitudes. There was a significant interaction effect for empathy condition, attachment category and the left- and right-clustered electrodes, however. Moreover, consistent with my hypotheses, the effect was larger in the left than right hemisphere as the left hemispheric effect had a larger effect size.

My second hypothesis was that those participants with high attachment anxiety who were exposed to low empathy would have a greater P300 amplitude for angry-faced images compared with participants who had high attachment anxiety and were exposed to high empathy. To test

this hypothesis, I conducted a one-way ANOVA for participants with high attachment anxiety to discern the influence of empathy category on P300 amplitude for angry-faced pictures. Levene's test was significant for the left-clustered electrodes suggesting a lack of homogeneity of variance, while it was non-significant for the right-clustered electrodes. The relationship between empathy category and P300 amplitude was not significant for the right-clustered electrodes, $F(1, 18) = 1.518$, $p = .235$, $\eta^2 = .082$. Because of a lack of homogeneity of variance for P300 amplitude on the left-clustered electrodes, I computed a Mann-Whitney U test which was significant, $U = 73.000$, $p = .016$, $r = .506$, suggesting that empathy category did indeed influence the P300 amplitude for angry-faced stimuli among high attachment anxiety participants. Mean P300 amplitude was higher at the left-clustered electrodes for the low empathy condition ($M = 5.587$, $SD = 2.571$), than the high empathy condition ($M = 1.839$, $SD = 3.779$). As such, my hypothesis that P300 amplitude for angry-faced pictures would be higher in the low than high empathy condition for high attachment anxiety participants was affirmed.

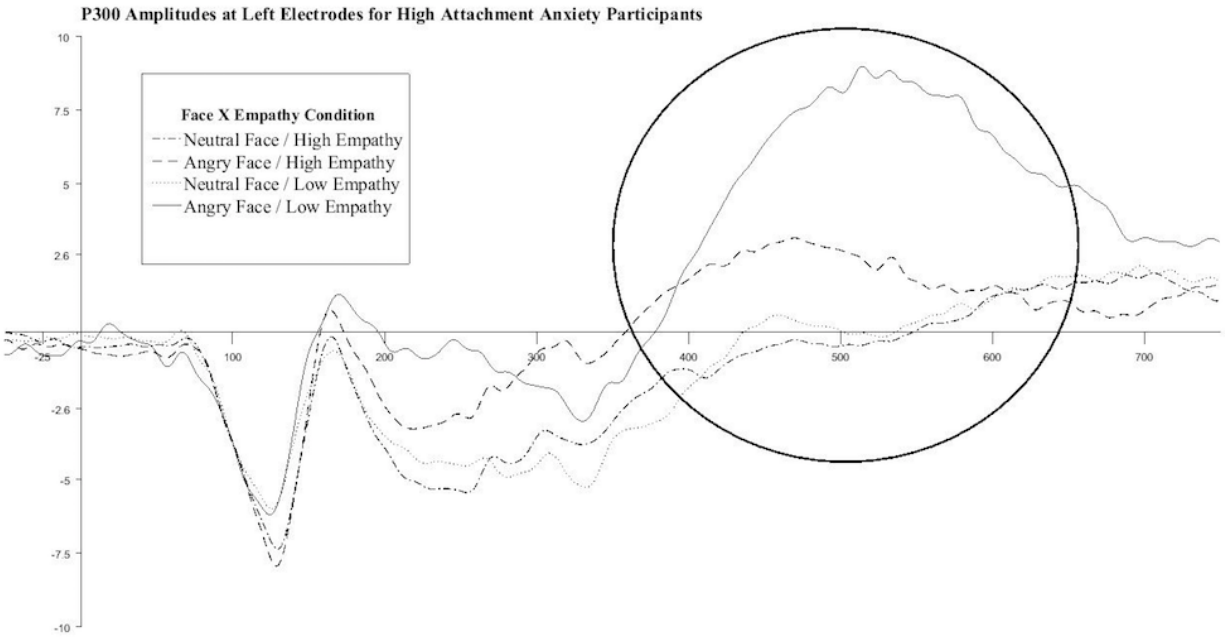

Figure 2. Grand averaged waveforms for left electrodes (F3, F5, AF3, AF7) for participants with high attachment anxiety

For my third hypothesis, I suggested no group differences would be found by empathy category for the P300 amplitudes for angry-faced images for low attachment anxiety participants. A one-way ANOVA was computed to discern if empathy category influences P300 amplitudes for angry-faced images for participants with low attachment anxiety. Levene's test was non-significant for both left- and right-clustered electrodes suggesting homogeneity of variances for both hemispheres. No significant differences were found by empathy category for either the left-clustered electrodes, $F(1, 19) = 3.409$, $p = .081$, $\eta^2 = .159$, or the right-clustered electrodes, $F(1, 19) = 2.905$, $p = .106$, $\eta^2 = .139$. Consistent with my hypothesis, P300 amplitudes did not differ significantly between empathy conditions bilaterally for participants of low attachment anxiety.

Table 2
Mean P300 amplitudes for angry-faced images grand averaged for left and right electrode sites for attachment anxiety category by empathy condition

Attachment Anxiety Category	Empathy Condition	*Hemisphere*	*M*	*SD*
High	High	Left	1.839*	3.779
		Right	3.112	3.458
	Low	Left	5.587*	2.571
		Right	5.062	3.330
Low	High	Left	5.170	3.989
		Right	5.057	4.243
	Low	Left	2.285	2.916
		Right	2.324	2.779

Means for significant differences for attachment anxiety category by empathy condition and hemisphere
* Significant at $p = .016$

My fourth hypothesis was that high attachment anxiety participants would have higher P300 amplitudes for angry-faced images than low attachment anxiety participants when empathy conditions are combined. To test this hypothesis, I computed a one-way ANOVA for P300 amplitudes at the left- and right-electrode clusters for high and low attachment anxiety

participants. Levene's test was non-significant for both electrode groupings, suggesting homogeneity of variance across groups. No significant differences were found for the left-electrode cluster, $F(1, 38) = .067$, $p = .796$, $\eta^2 = .159$. Similarly, there was no significant effect for the right-electrode cluster, $F(1, 38) = .044$, $p = .836$, $\eta^2 = .139$. In contradiction to my hypothesis, I discovered no difference between P300 amplitudes for angry-faced images for high and low attachment anxiety participants.

I also analyzed whether the reverse was true, and empathy influenced participant P300 amplitudes irrespective of their attachment anxiety group. Levene's test was non-significant, suggesting homogeneity of variances. Empathy did not exert a significant effect for the left clustered electrodes, $F(1, 38) = .075$, $p = .786$, $\eta^2 = .002$. Moreover, no significant empathy effect was observed for the right clustered electrodes, $F(1, 38) = .184$, $p = .670$, $\eta^2 = .005$. Accordingly, empathy condition did not significantly influence participants' P300 amplitudes for angry faces at either the right- or left- clustered electrodes.

Discussion

In the present study, I investigated how participants' attachment anxiety and empathy for pain received from an unfamiliar observer influence neurophysiological indicators of emotional adjustment to pain. Using Coan's (2008) Social Baseline Theory, and Bowlby's (1977) attachment theory, I posited that attachment anxiety would interact with empathy to influence participants' attention to negative social stimuli. Moreover, I expected this effect to be lateralized to the left hemisphere because the social-proximity of attachment figures is associated with approach behavior (Ainsworth & Bell, 1970) and such approach behavior is related to left-lateralized prefrontal activity (Coan, 2008). I also hypothesized that while higher support from a perceived unfamiliar observer would relate to lower attention to negative stimuli for persons of

high attachment anxiety, no such difference would be visible for persons of low attachment anxiety. Further, I hypothesized that attention would be greater in the high attachment anxiety group than the low attachment anxiety group for angry-faced images regardless of empathy condition. I investigated these hypotheses using an experimental paradigm wherein participants were asked to undergo a cold-bottle pain stimulation task, after which they were given a falsified empathy rating, and then completed a task in which they were required to discriminate between neutral and angry-faced images while being recorded with EEG according to the Event-Related Potentials technique.

Summary of Major Findings

With regards to my results, I found support for my first hypothesis. Specifically, an interaction effect was observed, suggesting that empathy condition and attachment category influenced differences in the neural correlates of attention to angry-faced images. Interestingly, this interaction constituted a crossover effect, where attachment anxiety category and empathy condition significantly related to attention for the negative stimuli together but not alone. It is worth noting that these findings depart from research which has shown attachment anxiety to relate to such attention for angry-faced images (Mark et al., 2012). The empathy manipulation appears to be responsible for the finding in the present study, particularly considering the crossover effect, which would suggest that participants of high and low anxiety responded to high or low expressions of pain empathy in opposite ways. As expected, this effect was also primarily left-hemisphere lateralized.

In confirmation of my second hypothesis, among participants with high attachment anxiety those with low empathy demonstrated greater attention to the angry-faced images than those who received high empathy. The significance of this finding is further shaped by the fact

that it was only significant in the left hemisphere. Greater relative activation in the left compared to right Prefrontal Cortex (PFC) has been associated with greater approach behavior while the reverse pattern has been suggestive of greater withdrawal behavior (Coan, 2008). Accordingly, participants with high attachment anxiety who received low empathy expended more neural resources in their greater approach orientation toward angry-faced images than participants of high attachment anxiety who received high empathy. Thus, it may be bioenergetically more adaptive for persons of high attachment anxiety to receive a high degree of expressed empathy for their pain. Further, when given a high degree of expressed empathy for their pain, persons of high attachment anxiety may attend less to negative social expressions in others. Because biased attention for negativity is associated with depression and anxiety (Chavis & Kisley, 2012), such support may lead to better psychosocial adjustment (i.e., fewer depressed or anxious symptoms).

Confirming my third hypothesis, in contrast to the pattern observed in participants high in attachment anxiety, attention for angry-faced images was not influenced by empathy condition for participant groups that were low in attachment anxiety. As such individuals are characterized by more secure attachment, I did not expect them to benefit from the support of a stranger, rather I expected they would rely on internalized representations of positive attachment figures accrued throughout their development, as suggested by Mikulincer and Shaver (2003).

Though a non-significant effect, among participants who were low in attachment anxiety, those who were given high empathy demonstrated greater attention for the angry-faced images than those who were given low empathy. It is possible such a trend may be due to such low attachment anxiety participants' reliance upon other secure attachment relationships. For instance, Johnson and colleagues (2013) demonstrated reduced activity in the left supplementary motor cortex and right dlPFC for women holding the hand of a partner while threatened with

electric shock after a course of Emotion-Focused Couples Therapy (EFT), but increased activity in those brain regions after EFT when holding the hand of a stranger. Consistent with Coan's (2008) understanding that couples in invested relationships become a part of each other's self-regulation strategies, perhaps it is more disorienting to be supported by a stranger when one is securely attached.

Counter to my expectations, attachment anxiety did not relate to differences in attention for angry-faced images when empathy was not regarded, disconfirming my fourth hypothesis. Initially, I had hypothesized that persons with high attachment anxiety would have higher attention for angry-faced images than persons of low attachment anxiety regardless of empathy condition because Mark, Guerdes and Becker (2012) demonstrated such a pattern in their study. It is possible the unobserved effect for attachment anxiety category could have been because Mark and colleagues' study involved no empathy manipulation. Again, even participants who received low empathy in the present study received some empathy. Consistent with Sambo and colleagues' (2010) proposition that those with higher attachment anxiety might regard expressions of empathy from a stranger as soothing, it is possible that the provision of any empathy for high anxiety participants helped to lower their perceived need to attend to angry-faced images, such that there was no difference between their group and the low attachment anxiety group.

Implications for Theory

In the present study, I tested propositions based on Coan's (2008) Social Baseline Theory and Bowlby's (1977) attachment theory. Results from the present study could suggest an unexpected, and in some ways maladaptive, use of *load sharing* on the part of participants with high attachment anxiety. According to Social Baseline Theory (Coan, 2008) *risk distribution*

occurs when individuals perceive reduced threat by virtue of being surrounded by others, while *load sharing* occurs when the demands of emotional regulation are shared between two mutually invested individuals. Therefore, though *risk distribution* may take place between strangers, *load sharing* is thought to be specific to attachment relationships (Coan, 2008). As Coan has noted, in *load sharing* relationships, individuals become one with each other's emotional regulation strategies. While such behavior is adaptive in stable relationships, it is obviously problematic and precarious between strangers who may or may not be reliable. As Johnson and colleagues (2013) have noted, relational partners can be counted on to a greater degree than strangers when it comes to caring for the young, sharing goals, helping when one is injured or ill and sharing threat vigilance. In the present study, empathy ratings were fabricated. The high attachment anxiety participants who were given high pain empathy and demonstrated lower attention to the angry-faced images in this study compared with their counterparts who received low pain empathy, therefore, may have staked their self-regulation strategy in unfamiliar observers who were not real.

The notion that differences in attention for the high attachment anxiety participants were due to an inappropriate use of *load sharing* is supported by the pattern of neural activity that I observed. Indeed, this effect occurred in electrodes overlying the left dorsolateral Prefrontal Cortex (dlPFC). According to Coan (2008) while *risk distribution* is not thought to be mediated by cortical processes, *load sharing* is thought to influence cortical, prefrontal brain regions. Specifically, while ventromedial and medial prefrontal cortical regions have been associated with automatic affective self-regulation, the dorsolateral prefrontal regions are thought to "modulate cognitive operations associated with attachment figures in reflective, working memory" (Coan, 2008, p. 8). Such strategies may be engaged through "explicit, cognitive, or 'reappraisal' based

self-control strategies active during unpleasant emotional states" (Johnson et al., 2013, p. 7). That is to say, there is evidence that *load sharing* is typified by the effortful self-control of emotion as influenced by one's impressions of their attachment support and modulated in large part by the dlPFC along with other associated structures.

Coan has suggested that the resulting effect is such that in intimate relationships where *load sharing* occurs, partners "invest less effort in down-regulating their negative affect, leaving them less responsive to threat cues and other signs of possible harm" (Coan, 2008, pp. 20-21). Said otherwise, partners have less of a need to utilize costly neurometabolic resources in *load sharing* relationships because they share the burden of guarding against threat with another and therefore have less of a need to be vigilant for that threat and less of a need to exert self-control strategies for managing their emotional discomfort with regards to the threat. Consistent with this, Beckes and Coan (2010) have noted that self-regulation circuits in the dlPFC are indeed less active when social support is provided. Moreover, Johnson and colleagues (2013) have noted reductions in right dlPFC activity among women who are threatened with electric shock while holding the hand of their partner and after having gone through Emotion-Focused Couples Therapy, therefore suggesting that consistent with *load sharing*, improvement in one's bond with a partner may lead to the reduced expenditure of neurometabolic resources in the dlPFC.

The present research also lends support for Brennan, Clark and Shaver's (1998) elucidation of anxious attachment and Mikulincer and Shaver's (2003) understanding of secure attachment. Brennan and colleagues have described attachment anxiety as associated with a negative model of self and worry regarding abandonment. Moreover, in their creation of the original Experiences in Close Relationships scale, they described their anxious attachment sub-scale correlated highly with other scales which measured preoccupation with attachment,

anxiety, fear of rejection and jealousy. The present finding that, among participants with high attachment anxiety, those who received high empathy demonstrated lower attention for the angry-faced images compared with those who received low empathy would support this conceptualization that attachment anxiety is associated with a preoccupation with attachment and a need for reassurance.

Moreover, these findings at least partially support Mikulincer and Shaver's (2003) assertion that attachment security is grounded in internalized representations of positive attachment figures. In the present study, participants low in attachment anxiety did not demonstrate differences in their attention to angry-faced images according to the empathy rating they were given by the falsified unfamiliar observers. While it is unclear if participants of low attachment anxiety modulated their attention for the angry-faced images by drawing on such internalized representations of attachment figures, their attention did not seem influenced by sources of support outside of their attachment system.

Implications for the Psychological Treatment of Chronic Pain

Several important implications with regards to the psychological pain treatment of women can be drawn from the present study. While I propose that differences in attention to angry-faced images among women with high attachment anxiety were due to *load sharing*, and that it is maladaptive for these women to engage in *load sharing* with a stranger, psychologists should not interpret this assertion to mean that one ought to ignore requests for support from female patients with pain who appear to demonstrate attachment anxiety (e.g., those who appear "needy"). Indeed, it would be wrong to assert that because women of high attachment anxiety may be overly-sensitive to the support of strangers, they should therefore not be given support by persons outside of their attachment system.

Consideration of the study of Forsythe, Romano, Jensen and Thorne (2012) may help to emphasize why such support may yet be beneficial for patients. They have demonstrated that while positive spousal responses to pain behavior are associated with more pain behavior, they are also associated with the endorsement of fewer symptoms of depression, while negative spousal response to pain behaviors were associated with both increases in symptoms of depression and pain behavior. While I discuss the present findings in the context of support from one outside of the patient's attachment system, they may represent a valid analogue to the findings of Forsythe and colleagues. I would propose that *load sharing*, indeed, is responsible for both the effects among participants with high attachment anxiety in this study, and among patient and spouse pairs in the study of Forsythe and colleagues. Insofar as support may both relate to increased pain behaviors and decreased symptoms of depression, such care is not uniformly good or bad, but has complex consequences for patients' psychosocial coping.

In the context of chronic pain treatment, psychologists have the opportunity to provide support as a person outside of the patient's attachment system. While it would behoove clinicians to address patients' relational style when they present with attachment anxiety so that they may build more stable attachment relationships, the present study would suggest that the intentional provision of moderate to high degrees of empathy for such patients may also further that goal by enabling them to attend less to the unsupportive expressions of others. Moreover, such empathy may represent an opportunity to proximally diminish patients' bias to negative social information and, since such bias is linked with depressive and anxious symptomatology (Chavis & Kisley, 2012), distally prevent or reduce psychopathology as a result of pain experience.

Limitations

There are several limitations to the present study. First, the present analysis only utilized a sample of females. There were several reasons for the exclusion of males in this study. For one, the experience of pain appeared to be more strongly influenced by social factors for women than men (e.g., Chambers et al., 2002; Jackson et al., 2005). Moreover, past research would suggest that males might be more motivated to conceal their pain (Robinson et al., 2001), which might have influenced their reception of the empathy rating. Finally, past research has suggested that different dimensions of attachment might more strongly influence relational outcomes according to one's gender, with attachment anxiety more strongly predicting outcomes for women (Collins & Read, 1990; Consedine & Fiori, 2009) and attachment avoidance more strongly predicting outcomes for men (Collings & Read, 1990; Monteoliva et al., 2012). As such, it is possible that male participants would have responded to the empathy manipulation in a manner different from the female participants, and attachment avoidance rather than anxiety may have been more predictive of their attention to angry-faced images. Accordingly, the findings of this study cannot be easily generalized to males.

Furthermore, the application of experimental pain studies to clinical pain must be considered carefully as well. As Hurter and colleagues (2014) have noted, clinical pain carries more stress and personal meaning than experimental pain. Moreover, they have suggested that even empathy ratings from one's romantic partner are not a natural analogue for expression of partner empathy in real-world contexts. Accordingly, the usage of a cold bottle for pain stimulation in a healthy population cannot be considered a direct analogue for chronic pain experience, nor can the numerical expression of empathy from a falsified unfamiliar observer be considered the same as a clinician's expression of care. For the sake of ecological validity,

further research should seek to confirm the pattern of findings in this study with clinical populations, in clinical settings (e.g., patients with chronic pain at a pain clinic).

Finally, one must be cautious not to infer causation from the above analyses. This study utilized a quasi-experimental design, and no participant received all the empathy conditions. In designing the empathy manipulation, I felt it too suspicious to inform participants that two unfamiliar observers would be watching from a different room and to provide them with both a high and low empathy rating with separate cold bottle and visual discrimination tasks. Perhaps future replications may be successful in administering both empathy conditions to participants if they utilize actual research confederates as unfamiliar observers. As such, the present analyses have only investigated group differences in response to the angry-faced images according to attachment anxiety category and empathy condition and I am unable to indicate that differences in P300 amplitudes were in fact caused by differences in the provision of empathy for participants with high and low attachment anxiety.

Study Strengths and Implications for Future Research

This research makes a significant contribution to existing knowledge in several ways. It contributes to our understanding of how attachment and empathy for pain provided by unfamiliar others may influence subsequent biases in attention for negative social interactions. While past studies have suggested that negative biases in attention are associated with anxiety and depression (Chavis & Kisley, 2012), and partner support for pain behaviors relate to reduced endorsement of depressive symptoms among patients with chronic pain (Forsythe, Romano, Jensen & Thorn, 2012) no study has yet investigated how support may work to reduce bias for negative social stimuli.

The present study also illustrates the importance of considering attachment when investigating how individuals cope with threat relationally. While studies such as Coan and colleagues (2006) and Johnson and colleagues (2013) have made strong contributions to our understanding of how partner support influences adjustment to threat, the current findings would suggest attachment anxiety to be an important factor to consider when investigating how women socially cope with threat. Future research addressing self-regulation in the context of threat should therefore consider attachment characteristics as they interact with the gender of participants.

I would suggest several avenues for future research. First, future researchers could potentially replicate these findings with unfamiliar observers represented by research confederates to discern whether the observed effects persist or are different when participants meet individuals whom they believe will be rating empathy for their pain. Secondly, to expand on the present study, researchers should investigate how support from partners influences attention to negative social stimuli among participants with secure attachment. Consistent with Coan's (2008) SBT and understanding of *load sharing*, I would propose that secure individuals would demonstrate a similar pattern of results with regards to empathy from a partner as was seen in the present study for participants high in attachment anxiety who received empathy from simulated unfamiliar observers. Such findings would even more clearly explain the findings of Forsythe and colleagues (2012) and lend further support to the notion that partner support in the context of pain relates to reduced depressive symptomology through minimizing one's bias in attention for negative social interactions.

Moreover, future studies should investigate whether a bias in attention for negative social stimuli influences the incidence of symptoms of depression and anxiety among patients with

actual chronic pain conditions. Rather than utilizing an empathy manipulation, such a study may utilize a measure of perceived partner support, a measure of anxiety or depression and a similar visual discrimination task with the Event-Related Potentials technique, to discover how such perception of support and attention for face images relates to the incidence of symptoms of pychopathology. It would be important to keep in mind, however, that research suggests anxiety and depression are implicated in different forms of negative attentional bias, such that attention is related to bias for threatening images (Bar-Haim et al., 2007; Chavis & Kisley, 2012) while depression may be related more to sad images (e.g., Bistricky et al., 2014). Such a study would further increase the ecological validity of this line of research by demonstrating that social support for pain influences psychopathology through modulating attention to negative social stimuli.

Conclusions

In the present study, I investigated how participants' attachment anxiety and empathy received from others for experimentally stimulated pain influenced attention to negative social stimuli. The findings would suggest that differences in the provision of high or low empathy from unfamiliar observers for persons with low attachment anxiety does not influence their attention to negative social images. On the other hand, persons high in attachment anxiety who were given high pain empathy from unfamiliar observers did demonstrate lower attention for negative social images than persons high in attachment anxiety who were given low pain empathy. While these findings require further replication, they would suggest that persons of high attachment anxiety who are being treated for chronic pain benefit from greater compared to lesser expressions of empathy from persons outside of their attachment system, which could include their psychological treatment providers. Moreover, insofar as participants of high

attachment anxiety who received high empathy appeared to demonstrate lower attention to negative social images through Coan's (2008) concept of *load sharing*, I suggest such persons with high attachment anxiety would likely benefit from psychological treatment tasked with helping them seek and maintain appropriately stable sources of support, rather than being so susceptible to the support, or lack thereof, of non-attachment figures.

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Appendix A – Literature Review

The International Association for the Study of Pain Task Force on Taxonomy has described pain as "an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage" (International Association for the Study of Pain, 2014). According to the Institute of Medicine (2011) chronic pain affects over 100 million Americans at a cost of over $635 billion dollars per year. Taylor (2012) described that chronic pain, unlike acute pain, lasts 6 months or more after injury and either maintains severity or increases over time, carrying the additional load of psychosocial distress. The distress accompanying chronic pain is associated with a variety of ailments from negative mood and depression to lowered activity levels and physical dysfunction (Jensen & Turk, 2014, p. 105).

Attachment style is an important variable for consideration in the treatment of chronic pain. Insecure attachment is associated with a broad range of negative outcomes ranging from feeling less capable of coping with pain to reporting more physical symptoms and higher pain intensity (Meredith, Ownsworth & Strong, 2008). Pietromonaco Uchino and Dunkel-Schetter (2013) called for researchers to examine mediators and outcomes (e.g., responsiveness, commitment, satisfaction) of attachment, and resulting responses in physiology, affect and behavior. This research will help psychologists tailor treatment interventions for people with chronic pain.

Researchers have established that received empathy and attachment are capable of influencing perceptions of physical pain (e.g., Hurter, Paloyelis, Williams & Fotopoulou, 2014; Sambo, Howard, Kopelman, Williams & Fotopoulou, 2010). The next step is to study how empathy in the context of attachment style may influence physiological indicators of emotional adjustment to pain. There is evidence that negative emotions are linked with pain disorders and

that negative mood states result from a combination of biases in information processing and pain (Meredith et al., 2008).

Attention is a cognitive construct of interest in addressing the association between attachment and adjustment to pain. Coan (2008) recently described a novel neuroscientific approach to attachment, which suggests attachment influences emotional regulation by altering one's perceptions of threat in the environment. According to this theory, securely attached persons who are in the presence of a caring other experience a reduction in self-regulatory neurological activity because they have less need to attend to the threats within their surroundings.

The Event-Related Potential (ERP) could help advance our knowledge of attention in the context of attachment and threat. This technique is an elaboration of electroencephalography (EEG), wherein electrical activity in the brain is time-locked to a stimulus so that one's reaction can be observed down to the millisecond (Luck, 2005). Grand-averaging electrical brain activity across selected electrode sites results in a waveform. Components within any waveform are delineated in terms of their positive or negative-going peaks and by their order, such that P1, N1, P2, N2, and P3 refer to the valence of the component and its place within that waveform (Luck, 2005). In particular, one component of the ERP, the P3 or P300 may be most suitable to studying the relationship between attachment and coping with threat, insofar as the P300 appears to represent attention to task-relevant shifts in stimulus presentation (Luck, 2005).

I sought to extend past research on the influence of empathy on pain adjustment by addressing how empathic support for pain in the context of attachment influences the allocation of neurobiological attentional resources. Past researchers have found attachment anxiety is more strongly associated with attention to negative social information than attachment avoidance

(Mark, Guerdes & Becker, 2012) and have found that women may be more responsive to expressions of support for pain than males, at least as regards their perception of pain intensity or tolerance (ex. Chambers, Craig & Bennett, 2002; Jackson, Iezzi, Chen, Ebnet & Eglitis, 2005). Thus, in the present study I have focused specifically on women as my population.

Pain

Definitions of Pain

Before addressing the relationship between pain and attachment, it would be appropriate to discuss the definition of "pain." Pain has been described as an experience with three important qualities: (a) unique perceptual and sensory characteristics; (b) being without a clear relationship to tissue damage; and (c) an "unpleasant emotional experience" (Eccleston & Crombez, 1999, p. 356). The understanding of pain as a concept has had a long and storied history, though, characterized by numerous paradigm shifts (Gatchel et al., 2014). Gatchel and colleagues have noted that several thousand years ago, exorcism and trephination were the decided "cures" for pain conditions, which were ascribed to dysfunctions in everything from religious concerns to the heart or brain. Such hermeneutic models eventually gave way to biomedical understandings focused on the remediation of pain with substances and finally more integrated models composed of biological, psychological and social considerations (Gatchel et al., 2014).

Biomedical Definitions. Gatchel and colleagues have described two biomedical models descended from the Cartesian notion that there is a direct relationship between tissue damage and pain (2007). "Specificity Theory" holds that information about pain is transduced from peripheral afferents to the brain through the spinal cord via "unique receptor mechanisms and pathways" (Gatchel et al., 2007, p. 582). Alternatively, "Pattern Response" theory suggests that information about pain is the result of the intensity of the stimulus along with a "pattern of

response" in the systems, which transmit to the brain (Gatchel et al., 2007, p. 582). Ultimately, managing pain biologically without consideration for psychological or social inputs limited the usefulness of these theories, as consideration of non-physical concomitant elements introduces additional means of treating pain that have been efficacious (Gatchel et al., 2014).

Biopsychosocial Definitions. Pain and disability, within the context of the biopsychosocial model, can be seen as a "complex and dynamic interaction among physiological, psychological, and social factors that perpetuate, and even worsen, one another, resulting in chronic and complex pain syndromes" (Gatchel et al., 2014, p. 120). This model also recognizes, in contrast to the Specificity Theory, that there is no direct correspondence between degree of tissue injury and pain experience (Gatchel et al., 2014). Instead, according to Gatchel and colleagues, emotions and cognitions are seen as influencing biologically-based pain processes, and capable of amplifying pain experience.

Gate Control Theory

Melzack and Wall's Gate Control Theory (GCT) is one such integrative model which served to unite the biomedical approach with motivational inputs (Gatchel et al., 2007). This model considered that there is a certain degree of correspondence between pain and tissue damage, that pain information is processed in a pattern of neural networks, and that the experience of pain is influenced by emotional and cognitive elements (Gatchel et al., 2007). According to GCT, a gate mechanism in the dorsal horn of the spinal column controls the perception of pain (Melzack, 1993). Afferent fibers transmit to T- (transmission) cells, which are modulated by this gating mechanism. Large fiber activity will close the gate, while small fibers open the gate. Efferent fibers, sending information from the brain to the dorsal horn of the spinal column influence this gating mechanism. These large-diameter, descending nerve fibers can

activate cognitive processes such as psychological distress, that influence the gate (Melzack, 1993; Melzack, 2001). Finally, when T cells reach a critical level, they activate the pattern of behavior and experience that we know as pain (Melzack, 1993). The GCT, then, suggests that while pain may be related to tissue damage, psychological mechanisms are capable of mediating the experience of this pain through afferent and efferent nerve fiber networks.

Neuromatrix Theory

The neuromatrix theory of pain expanded upon the GCT (Melzack, 2001). Despite its comprehensive nature, Melzack (2001) noted that the GCT was unable to explain "phantom limb pain," or the pain sometimes experienced by amputees as being present in the lost limb. Melzack (2001) described that phantom limb pain was theorized to derive from sources within the brain itself instead of solely in midbrain or spinal structures addressed by the GCT.

Extending the GCT, Melzack proposed that the anatomical structures that contribute to perception of one's "body-self" (perceived unity of body with "self") are networks of neurons that loop between the limbic system and cortex and also the cortex and thalamus (2001, p. 1379). A "neurosignature" results from the repeated processing of nerve impulses synthesized together through this neuromatrix. This neurosignature, is projected to the "sentient neural hub" which is responsible for converting nerve impulses into conscious awareness. The neurosignature can also activate other networks in the brain responsible for producing movement toward a goal. Ultimately, this process results in a neurosignature that encompasses the whole body and results in a unified sense of self (Melzack, 2001). As such, Melzack suggested that phantom limb pain may be influenced by structures beyond the spinal cord and midbrain, instead relating to issues in the neural networks processing pain experience within the brain.

Beyond its ability to address phantom limb pain, the neuromatrix theory of pain is also useful in that it elucidates the cyclical interactions between pain processing in the brain and worsening biological damage. Melzack noted that pain also "disrupts the brain's homeostatic regulation systems" resulting in stress and processes which seek to resolve that stress (2001, p. 1380). He described that a fundamental hormone implicated in return to homeostasis is cortisol, which produces higher levels of glucose enabling a fast response to the injury or crisis. He indicated, though, that the unfortunate side effect of extended cortisol exposure is inhibition of calcium replacement in bone and breakdown of muscle protein, which may lead to further issues with chronic pain (Melzack, 2001). Melzack noted that physical and psychological processes may disrupt systems tasked with the regulation of stress resulting in muscle, bone and nerve tissue lesions which contribute to chronic pain (2001). For instance, stress associated directly with chronic pain experience or depression secondary to a chronic pain issue may disturb stress regulation leading to further biological damage and pain by the action of cortisol.

Applicability of Chronic Pain Treatment to Psychology and Counseling Psychology

Such models as the GCT and Neuromatrix highlight the importance of not only physical but also psychological health in the treatment of patients with chronic pain. Indeed, Turk has described that persistent pain is demoralizing and "confronts the individual not only with the stress created by pain but with a cascade of ongoing stressors that compromise all aspects of their lives" (Turk, 2001, p. 118). Such stress, moreover, depletes emotional resources and taxes others within one's support system like family members, friends and coworkers (Turk, 2001). As such, integrated pain management programs which incorporate psychological treatment along with medical and physical rehabilitation have been found to be the most cost-effective options in

long-term care and more beneficial to patients than a solely medical approach (Gatchel et al., 2014).

Jensen and Turk have noted that, ideally, chronic pain patients should be matched "to particular treatments based on relevant predictive characteristics" (Jensen & Turk, 2014, p. 114). Such an emphasis is consistent with the recommendations elucidated by the APA Presidential Task Force on Evidence-Based Practice. In 2006, this task force defined evidence-based practice in psychology (EBPP) as "the integration of the best available research with clinical expertise in the context of patient characteristics, culture and preferences" (APA Presidential Task Force, 2006, p. 273). Despite the myriad of coping strategies with demonstrable effectiveness in managing chronic pain, however, attempts to customize pain treatments for patients have been limited, instead favoring a "one size fits all approach" (Forys & Dahlquist, 2007, p. 22).

Counseling Psychology is well-positioned to respond to such myopic treatment foci. Indeed, Packard (2009) identified social justice and advocacy as core values for this discipline. Speaking to the identity of Counseling Health Psychology, Nicholas and Stern (2011) wrote

> The normative or nonpathologic lens through which to view many developmental issues across the life span, resulting in a strength-based approach emphasizing primary prevention over remediation reflects both current and long-term values, attitudes, and identity of counseling psychology. In more recent years, theories, models, and procedures have emphasized the provision of culturally sensitive health care, with multicultural competence, and awareness and sensitivity to issues of social justice as represented in many health care disparities and diverse populations. (Nicholas and Stern, 2011, p. 334)

It is well within the interest of Counseling Health Psychology, then, to explore differences in patient characteristics in the provision of health care services, and to offer guidance for prevention and socio-culturally responsive treatment.

Attachment

Preceding any discussion of the influence of attachment on physical or psychological pain experience, I will address the construct of attachment. Bowlby (1977) described attachment in terms of one's behavior in securing and retaining relationships with close others. Although attachment theory originated out of Bowlby's psychoanalytic influences, he noted that it quickly discarded such abstract concepts as psychic energy. Instead, attachment theory sought early on to closely ally itself with the biological and cognitive sciences.

Bowlby (1977) indicated the importance of attachment behavior early in one's life as children appear to use an attachment figure, usually the mother, as a "secure base" from which to explore the world. Such relationships become internal working models for the child. As the child forms an understanding of how worthy of care he or she is and how worthy their caregiver is of trust, these representations begin to become more stable within the individual. Bowlby asserted his conviction that early attachment representations acquired by the child take on a trait-like character, influencing his or her ability to relate to others throughout the lifespan.

Speaking to the influence of evolutionary stresses on attachment, Bowlby (1973) noted how attachment behavior emerged from one's need to self-regulate in a threatening environment. He described that from a statistical standpoint alone, one is in more danger when on one's own, and so suspected that human beings are motivated to affiliate with others to distribute risk. This affiliation with others structured one's emotional and physiological regulation. He noted that when children are alone, they become distressed and yet experience relief upon the return of their

caregiver. Likewise, the presence of others confers physical survival benefits in that such social relationships may help one to procure food and other resources. Social affiliation in Bowlby's view, then, serves to support one emotionally and physiologically.

Ainsworth and Bell (1970) demonstrated many of these attachment hypotheses in their strange situation experiments. These authors observed children who were brought to unfamiliar rooms with their mothers and subsequently left alone or with a stranger. In support of the notion that attachment figures are secure bases from which to explore, they noted increased exploration behavior from children when their mothers were present. Children also appeared distressed when their mothers left and were relieved upon their return. Ainsworth (1989) has since supported that such attachment bonds may be formed outside of mother-child relationships, with fathers, siblings, friends and in sexual-pair bonds.

Conceptualizations of Attachment

Attachment can be conceived of along either a continuum or categorically (Forsythe et al., 2012). Continuous models of attachment view the construct along two dimensions: attachment avoidance and attachment anxiety (Forsythe et al., 2012). Alternatively, categorical models classify individuals into one of typically three to four attachment styles (Forsythe et al., 2012). Forsythe and colleagues cite the literature review of 25-years of attachment measure research done by Ravitz, Maunder, Hunter, Sthankiya and Lancee (2010) as reporting that it is still unclear as to whether attachment is inherently a dimensional or categorical construct (2012).

Meredith, Ownsworth and Strong (2008) described that the categorical model with greatest acceptance is that of Bartholomew and Horowitz (1991). Bartholomew and Horowitz structured their method on Bowlby's original conceptualization of attachment behavior as existing on axes of a model of self or other. The model of self was considered to relate to one's

perception of worthiness for help and support while the model of others component was thought to relate to one's perception about the availability and reliability of attachment figures. Individuals then, could be conceived along either of these two continuous dimensions, or these dimensions could be combined to identify categorical attachment constructs. Persons who have both a positive model of self and a positive model of others are labeled "secure" while those who have both a negative model of self and others are labeled "fearful." Those who have a positive model of self but a negative model of others are referred to as "dismissing" while those who have a negative model of self but a positive model of others have been described as "preoccupied."

Brennan, Clarke and Shaver (1998) elucidated another dimensional means of measuring attachment. They have defined attachment behavior in terms of anxiety and avoidance, referring to one's tendency to fear abandonment or to have trouble connecting with others respectively. These dimensions could be used in tandem to create attachment categories similar to those of Bartholomew and Horowitz (1991) however. Those high in both anxiety and avoidance have been labeled "disorganized" while persons low in both are "secure." Persons high in anxiety but low in avoidance are considered "anxious-ambivalent" while those low in anxiety but high in avoidance are considered "avoidant."

Significance of Attachment to Biological Health

Attachment-Biological Feedback. Research suggests that attachment styles influence more than an individual's relational health, but also exist in dynamic interplay with their physical health. Simon-Dack and Marmarosh (2014) have conceptualized attachment in terms of epigenetics. They noted that epigenetics refers to "how environmental and external influence on an organism will affect the process by which certain genes are expressed by that organism"

(Simon-Dack & Marmarosh, 2014, p. 530). Interactions between parents and children are therefore expected to shape the child's physiology and behavior via gene expression. This gene expression is thought to define neural development biologically with implications for regulation of emotion and response to social stressors (Simon-Dack & Marmarosh, 2014).

Illustrating attachment development as an epigenetic process, Simon-Dack and Marmarosh cite a study by Weaver and colleagues (2004), which addressed stress reactivity in rats as influenced by parental grooming and nursing behavior. They noted that infant rats cared for by mothers who engaged in more grooming and nursing engaged in less aversive reactions to stress in adulthood and were less fearful. Alternatively, rats that were cared for by mothers who did not attend to them as significantly reacted more strongly to stress, engaged in a greater degree of stressful behaviors, and experienced greater release of the stress hormone cortisol. According to Simon-Dack and Marmarosh (2014), Weaver and colleagues found indirectly increased expression of hippocampal receptors for a neurotransmitter that regulates and modulates stress behaviors in the rats that were cared for by highly attentive mothers. Rats that were cared for by mothers who engaged in less grooming and nursing were seen to have increased suppression of the gene regulating this stress-related neurotransmitter, which lead to greater stress reactions (Weaver et al., 2004 as cited in Simon-Dack and Marmarosh, 2014).

Attachment and Physical Health. Acknowledging that a large body of research has affirmed individuals who are insecurely attached are at greater risk for health issues, McWilliams and Bailey (2010) performed the first large-sample investigation of the relationship between attachment style and actual expression of health problems. Using the data obtained in the National Comorbidity Survey Replication (NCS-R), these authors investigated 15 health problems in their association with attachment; specifically, arthritis, back and neck problems,

headaches, other chronic pain conditions, allergies, stroke, heart attack, heart disease, high blood pressure, asthma, lung disease, high blood sugar, ulcers, seizures and cancer. They noted that the NCS-R was used to study the prevalence of psychiatric disorders in the civilian U.S. population, but that a subsample 5,692 individuals also completed Hazan and Shaver's (1987) attachment self-report measure yielding categorically secure, anxious, and avoidant attachment styles and were asked about health history. Because some 47 individuals did not complete every attachment style rating and were excluded from analysis, the final sample was composed of 5,645 individuals.

McWilliams and Bailey (2010) noted that about one-half of the health conditions investigated were associated with insecure attachment. The association between poor health and anxious attachment was stronger than for avoidant attachment, as this attachment style was related to more conditions, and these relationships were larger. Attachment Anxiety was significantly associated with back or neck problems, headaches, other chronic pain conditions, stroke, high blood pressure and ulcers. Avoidant attachment was significantly associated only with pain-related conditions such as back or neck problems, headaches or other chronic pain conditions. The authors did not stipulate what other conditions fell into the category of "other chronic pain" conditions, however.

The relationship between attachment, mental illness and health still requires further explanation, though. McWilliams and Bailey (2010) described they also decided to adjust their findings for the presence of psychopathology, as psychopathology shares some comorbidity with both physical health ailments and attachment concerns. For pain conditions, when the authors factored out history of psychiatric disorder, only the association between anxious attachment style and other forms of chronic pain (not arthritis, back or neck problems or headaches)

remained significant. They stated it was also possible that the results that avoidant and anxious attachment is associated with more negative health conditions than secure attachment may be due to the association between these attachments styles and neuroticism; as those who are more neurotic tend to exaggerate their physical symptoms. They have also noted that the relationship between insecure attachment and pain conditions may be mediated by psychopathology such as anxiety or depressive disorders. Psychopathological variables were not associated with cardiovascular conditions, however, and the authors found that anxious attachment was significantly related to cardiovascular issues even after adjusting for psychological problems.

In summary, attachment may relate to a broad range of physical health outcomes (McWilliams and Bailey, 2010) and influence behavior through altering gene expression (Simon-Dack & Marmarosh, 2015). Such studies as these demonstrate the complex relationship between attachment and physical health though, and one should continue to regard the direction of this relationship carefully. McWilliams and Bailey for instance were quick to note that their cross-sectional study design was a major limitation of their study insofar as it prevented investigation of the directionality of the relationship between attachment and health issues. The authors suggested that it was possible, for instance that apart from the notion that attachment insecurity influences greater incidence of health problems, health problems may strain relationships resulting in greater attachment insecurity.

Attachment is Associated with Chronic Pain. The literature addressing the influence of attachment style on chronic pain outcomes is growing. Perhaps affirming the suggestion of McWilliams and Bailey (2010) that health conditions may influence the incidence of insecure attachment, Forsythe and colleagues (2012) noted that attachment processes may be activated by pain and influence how one responds to pain as pain can represent a threat to one's well-being.

Surveying 158 couples with a partner experiencing chronic pain, these investigators used an index of the Relationship and Relationship Styles Questionnaires (RQ and RSQ respectively), two attachment scales to yield four continuous measures of attachment for each individual; secure, fearful, preoccupied and dismissive. They measured perceptions of spousal responses to pain behavior with the Spouse Response Inventory, pain intensity with the Wisconsin Brief Pain Inventory (BPI), self-reported pain behavior with the Pain Behavior Checklist (PBCL), disability with the Roland-Morris Disability Questionnaire (RMD-11), and depressive symptoms with the Center for Epidemologic Studies of Depression Scale (CES-D). They then used linear regression, controlling for pain source and intensity, to examine how attachment and perception of spousal support influenced their outcome variables outside of the influence of the pain conditions participants experienced.

The authors found that greater degrees of secure attachment related to fewer self-reported pain behaviors, symptoms of depression, less disability and lower reports of pain intensity. Conversely, greater levels of preoccupied and fearful attachment styles were associated with greater degrees of self-reported pain behavior, pain intensity, disability and depression. Perceived solicitous, or supportive, spouse responses to pain behavior were associated with depressive symptomology such that greater support related to endorsement of fewer depressive symptoms. Perceived solicitous spousal responses were also associated with more pain behavior, however. Alternately, greater perception of negative spousal response to pain behavior was associated with increases in both pain behavior and depressive symptoms.

The authors' findings regarding whether attachment mediated and moderated the relationship between perceive spousal response and pain behaviors or depression symptoms were mixed. Contrary to expectation, attachment style was not a moderator of associations between

pain-related outcome variables and perceived responses from spouses; that is attachment "did not enhance or dampen the association of perceived spouse responses with pain-related outcomes" (Forsythe et al., 2012, p. 298). As such, the authors suggested that attachment may be additive rather than synergistic to perceived spousal response to pain behaviors in influencing these variables. Alternatively, the authors noted that other variables may more greatly influence pain outcomes than attachment style, like personality variables or present relationship satisfaction.

Perceived negative response from one's spouse was a partial mediator between attachment style and self-reported pain behaviors. This partial mediation occurred between secure attachment as it related to lower depressive symptomology and preoccupied attachment as it related to greater expression of pain behaviors suggesting that individuals with greater degrees of these two attachment styles may respond differently to perceived negative spouse responses to pain behavior. Thus, they suggested "attachment style may influence how patients perceive and evaluate negative spouse responses, which in turn are associated with higher levels of pain behavior and depressive symptoms" (Forsythe et al., 2012, p. 298).

While this research yielded a variety of intuitive results, others were somewhat puzzling. Most perplexing is the notion that perceived negative spousal responses may mediate the relationship between pain outcomes (depression and pain behaviors) and attachment but perceived solicitous responses did not mediate the relationship between these variables. As a possible explanation, this writer would suggest a consideration of Bar-Kalifa and Rafaeli (2015) who have noted that partner support may be nonmonotonic. These writers have suggested individuals may have an internal baseline of expected support and while support below that threshold may have negative effects on affect, support in excess of one's baseline influences little positive affect change.

In broader strokes, Meredith and colleagues (2008) wrote that the literature has portrayed those with insecure attachment as being at greater risk of chronic pain, less capable when it comes to managing their pain-related distress, finding it more difficult to solicit and obtain social support, demonstrating issues forming therapeutic alliances that are secure, perceiving their health professionals as not acting in their best interests, acting as potential saboteurs of progress in therapy, and eliciting negative responses from their health professionals (2008). Furthermore, those who are insecurely attached, compared to those with secure attachment, have been shown to engage in emotion-focused rather than problem-focused coping, describe themselves as less capable of coping with their pain and viewing their pain as more threatening, and report higher levels of pain disability and intensity (Meredith et al., 2008). Moreover, those with insecure attachment report a greater degree of physical symptoms and pain related distress, depression, anxiety and catastrophizing along with lower-self-efficacy for dealing with pain compared to persons with secure attachment (Meredith, et al., 2008).

In summary, accounts in the literature of the relationship between attachment and pain are gradually growing clearer. Insecure attachment styles have been associated with health problems (McWilliams & Bailey, 2010) and also a variety of chronic pain complaints as well as risk factors for chronic pain (Forsythe et al., 2012; Meredith, et al., 2008). Continued research should focus on elucidating the mechanisms by which attachment influences adjustment to chronic pain.

Empathy for Pain

Recent literature has highlighted how attachment and perceived empathy may influence pain perception (Hurter et al., 2014; Sambo et al, 2010). Sambo and colleagues (2010) may have been one of the first groups to study the interaction of attachment, empathy and pain

experimentally. These authors investigated how 30 participants (20 female and 10 male) responded to thermal pain stimulation when in the presence of unfamiliar observers who communicated numeric ratings of empathy that were either high or low or when alone. Participants were told that unfamiliar individuals (research confederates) who had observed them during a pain threshholding period had rated his or her empathy for the participant's pain as either high or low on a scale of 0 ("no empathy") to 10 ("maximum"). Participants were then informed that the observer would be in the room with them to continue rating his or her empathy for the participant's pain throughout the experimental procedure. Each participant went through a high empathy, low empathy and alone condition, in counterbalanced order.

These authors found that higher attachment anxiety predicted lower self-report of pain on a visual analogue scale from "no pain" to "worst pain imaginable" when in the high empathy condition compared to the low empathy condition (Sambo et al., 2010). Attachment avoidance predicted lower self-report of pain when alone than with either high or low empathy observers. Sambo and colleagues offered then that those higher in attachment anxiety experienced lower pain with high empathy because they doubt the support of others and benefit from such reassurance. Those higher in avoidance, they suggested, experienced greater pain report when in the presence of others because of a preference for solitary coping.

Sambo and colleagues (2010) also looked at skin conductance response (SCR) and heart rate response (HRR). These writers found that post-stimulus SCR was lower for participants in the high or low empathy conditions than in the alone condition, but did not find a difference between empathy conditions. Post-stimulus HRR was also lower in the empathy conditions than in the alone condition, again without significant discrimination between empathy conditions. The same was true for pre-stimulus HRR, measured one-second before onset of the heat stimulus.

Attachment measures did not predict SCR or HRR in any of the conditions. In short, participants were more relaxed when with another person, regardless of the extent of that empathy, than when alone.

Hurter and colleagues (2014) investigated the relationship between attachment and perception of partner empathy on the report and display of pain. Their sample was composed of 54 healthy individuals (28 females, 26 males, with 48 heterosexual and 6 heterosexual individuals). Participants completed the Experiences in Close Relationships – Revised questionnaire (ECR-R) assessing attachment style. As the authors were interested in looking at specifically attachment anxiety and avoidance, they ensured that at least one individual from each couple scored highly on the avoidance or anxiety subscale of the ECR-R while dismissive individuals were excluded from the study. Participants also completed an assessment of relationship quality (Dyadic Adjustment Scale – 7) and the Pain Catastrophizing Scale (PCS).

Participants in three groups (avoidant, anxious or secure) were subjected to two manipulations (low or high empathy) during their cold pressor tasks. In the cold pressor task, participants were asked to submerge a hand in the water that was maintained at 2 to 4° C (Hurter et al., 2014). Participant couples then sat about 1 m apart, facing one another with a music stand positioned in front of each partner. The participating partner was asked to rate their pain by circling a number between 0 (for no pain) and 10 (for most severe pain). For the empathy manipulation, the observing partner was asked to rate his or her empathy for the participating partner by circling a number from 0 (no empathy) to 10 (most empathy) which would be alternatively discarded for a low or high number communicated by a researcher to the participating partner according to the manipulation.

The authors observed greater pain report in the high rather than the low empathy condition, which was not influenced by degree of pain catastrophizing (Hurter et al., 2014). Empathy was not found to influence tolerance of pain or facial display. The authors interpreted their findings as suggesting that when one interprets their partner as being empathic toward their pain, the salience of the pain is raised causing the participant to focus more on that pain, noting that past studies have demonstrated that pain can increase with greater attention toward it (Hurter et al., 2014).

Regarding attachment outcomes, the authors indicated that avoidant individuals reported and showed less pain during the high perceived partner empathy condition compared with the anxious and secure groups, and that there were no differences between the groups during the low empathy manipulation (Hurter et al., 2014). The authors suggested that this result supports their conjecture that pain ratings may have been influenced by salience derived from partner empathy. They reported that it is possible that salience may be dependent on trust for partner, resulting in a situation where anxious and secure individuals who trust their partners will experience pain as more salient with greater empathy while avoidant individuals who do not trust their partners will not experience pain as more salient when given greater empathy.

Krahe and colleagues (2015) recently published a study that demonstrated the utility of ERP investigations of attachment and pain response. Thirty-nine female participants were asked to rate their pain on a scale of 0 (“no pain”) to 10 (“worst pain”) in response to laser emissions of varying intensity under three conditions. In the *partner focus* condition the partner rated his empathy for the participant in response to data on the intensity of the laser stimuli while in the room with the participant, though the participant never saw these ratings. In the *other focus* condition the partner rated his empathy for another participant based on data of laser stimuli

while in the room with the participant. Finally, in the *partner absence* condition, the partner rated his empathy for another participant based on data of laser stimuli while in another room away from the participant. These investigators found that attachment avoidance was positively associated with higher N2 and P2 amplitudes, or the negative and positive going waves in the EEG data occurring approximately 200ms after stimulus onset, suggestive of the "conscious experience or 'perceptual outcome' of the sensory experience" of pain when the partner was present compared with the absence of the partner (Krahe et al., 2015, p. 2). Thus, in support of Sambo and colleagues findings (2010), avoidant individuals experienced greater distress when with their partner than when alone.

Empathy, then, appears to influence pain perception differently for different attachment configurations. Some of the conclusions of the aforementioned three studies appear to be in greater agreement than others though. Attachment avoidance appears to relate to lower pain report (Sambo et al., 2010) and lower neurological reactivity (Krahe et al., 2015) when alone, than when supported by others, or may even be uninfluenced by empathy manipulations (Hurter et al., 2014) suggestive of a general preference to cope alone, and potentially greater physiological reactivity when coping with pain in the presence of others. The relationship between attachment anxiety and pain perception is less certain, as Sambo and colleagues noted lower pain reports when given higher empathy ratings than low empathy ratings for pain, while Hurter and colleagues noted the opposite. Further research may benefit from replicating the studies of Hurter and colleagues and Sambo and colleagues with regards to exploring the influence of attachment anxiety and empathy on pain perception in order to clarify this relationship.

The Influence of Gender on Reception of Social Support for Pain

While considering how attachment may influence the reception of empathy or social support on adjustment to pain, it may also be important to account for the influence of gender. In one of the seemingly earliest studies to address gender and social influence on pain, Chambers and colleagues (2002) studied the relationship between sex, maternal support and pain among 120 children between 6- and 8-years-old (60 females and 60 males) undergoing a cold pressor task. Among other measures, children used The Faces Pain Scale to indicate their worst level of pain during the cold pressor task from among seven face pictures depicting increasing discomfort. They demonstrated that girls whose mothers spoke to them in a pain-promoting way reported greater pain intensity compared to either girls in a control group whose mothers "reacted spontaneously" or those in a group where mothers reacted in a pain reducing way (Chambers et al., 2002, p. 298). They also observed that girls whose mothers reacted to them in a pain reducing way reported lower pain intensity than girls in the control or pain-promoting groups. The same effect was not observed between mothers and sons however (Chambers et al., 2002).

Inspired by Chambers and colleagues (2002), Jackson and colleagues (2005) studied the influence of interpersonal transactions among adult men and women exposed to cold pressor pain. In their first study, 91 participants (34 male and 57 female) underwent the cold pressor trial when in either a no transaction (NT) condition where they could not talk to the researcher in the room or a transaction opportunity (TO) condition where they had the option to speak to the researcher if they would like. Pain intensity was measured by soliciting ratings on a scale of 0 ("no pain at all") to 10 ("severe pain") every 30-seconds during the cold pressor trial. Emotional support seeking was measured on the COPE scale, while coping strategies were measured on the Coping Strategies Questionnaire (CSQ). Pain-focus was also rated by blind raters who rated

transcripts of participants' verbalizations during the cold pressor trial. They found that for the TO condition, participants reported greater pain, emotional support seeking, and catastrophizing and less ignoring of their pain, but that there was no gender difference for these variables by condition.

In their second study, 126 adults (67 female and 50 male) were exposed to cold pressor pain using the previous two conditions (NT and TO) along with three more; having the researcher distract the participant from pain by asking questions about their lives (DT), guide the participant through reinterpreting their pain (RT) or provide encouragement and support (ET). Women in the DT, RT and ET conditions demonstrated higher pain tolerance as measured by the time they left their hand in the cold pressor voluntarily, than those in the NT and TO groups, while no such difference was present for men. These authors advocated, then, that in similar form to Chambers and colleagues (2002), it appeared that women responded to support that was pain-reducing by experiencing greater tolerance, while the pain report of men was relatively unaffected by the support of others.

It is important when considering the impact of gender on pain report in studies to consider gender-related expectations. Robinson and colleagues (2001) studied the perception of gender-role expectations for pain among an undergraduate sample (235 women and 156 men). Participants were given the Gender-Role Expectations of Pain (GREP) assessment rating one's perception of the sensitivity, endurance and willingness to report pain for each sex and their perception of their own standing on these indices with regards to what is typical for either sex. They noted both women and men reported believing men were less willing to report their pain and that the sex effect accounted for 46% of the variance in the difference between "perceptions of gender-stereotyped willingness to report pain" (Robinson et al, 2001, p. 254). These writers

have suggested that the response cost for reporting pain, particularly in experimental pain studies, may be higher for men than for women as it contradicts the stereotypical "tough" gender role expectation. In contrast, they noted relatively small differences are observed between sexes in studies of chronic pain. They suggested that the response cost for men may be lower in chronic pain populations as report of pain is integral to receiving appropriate medical care (Robinson et al., 2001). If males do indeed underreport their pain in experimental pain studies, research findings and implications for clinical treatment for men and women may be distorted by the perception that females' response to pain is exaggerated in comparison.

The influence of gender on pain experience in the aforementioned studies is rather mixed. Women seemed more receptive to the influence of social support on perception of pain intensity in the work of Chambers and colleagues (2002), as the pain tolerance of women was influenced by the social manipulations of Jackson and colleagues (2005). Sambo and colleagues (2010) demonstrated no relationship between gender and their outcome variables, however, and Hurter and colleagues (2014) only noted that they controlled for gender in their analysis without describing why or stating what effect they would have expected.

It is possible that one may make more sense out of how gender may influence pain experience if taken in consideration together with attachment. Fillingim and colleagues (2009) have noted that men and women have demonstrated differences in coping with clinical and experimental pain, and several recent studies have demonstrated that differing dimensions of attachment may be more or less important for relationship outcomes for different sexes (Collins & Read, 1990; Consedine & Fiori, 2009; Monteoliva et al., 2012). Indeed, research has suggested that attachment anxiety may be more predictive of relationship outcomes for women (Collins & Read, 1990; Consedine & Fiori, 2009) while attachment avoidance may be more

predictive of such outcomes for men (Collins & Read; Monteoliva et al., 2012). It is worthy of consideration, then, whether different dimensions of attachment may be more important for particular genders in influencing pain experience and adjustment insofar as gender-influenced attachment characteristics may influence the ability of someone to access and use available social supports.

Social Baseline Theory

Coan's (2008) Social Baseline Theory (SBT) may be helpful in conceptualizing how attachment relates to adjustment to chronic stressors such as pain conditions. Unlike animals who have evolved adaptations for existing in specific physical environments, Beckes and Coan (2010) have advocated that the dominant ecology of humans is other humans. It is difficult to conceptualize how attachment relations are accounted for by neural processes, however. As Coan (2010) has noted, the attachment behaviors described by Bowlby are not so tightly organized within the brain as they are in his model. Indeed, attachment relations appear to rely on dopaminergic projections through the brain in areas associated with such disparate processes as reward and punishment. Moreover, psychophysiological attachment processes are also influenced by neuropeptides like oxytocin and vasopressin. As such, Coan has argued that the brain itself is an attachment system and to paraphrase Wittgenstein, he proposed that to try to locate the attachment system in the brain was like trying to peal away the leaves to find the real artichoke.

In conceptualizing what attachment is within the brain, Coan (2008) has turned to bioenergetics. Consistent with Proffitt (2006), Coan has noted that in order to survive, one must take in more energy than goes out. Some of the costliest metabolic resources according to Coan are those related to emotional regulation in the frontal cortex. As such, Coan suspected that

people are motivated to avoid such bioenergetically expensive processes as emotional regulation whenever possible.

Coan (2008) has advocated that individuals avoid expending energy by essentially making bioenergetic "bets" on the environment. He noted the research of Profitt (2006) who described that persons who are wearing a heavy backpack estimate the incline of hills to be greater than those who are not. As such, though the body is prepared for coordinating the appropriate action, the mind is changing the odds of the "bet" by altering one's perception of the environment in order to discourage expending resources.

Coan (2008) has described two ways by which attachment influences one's perceptions of the environment. First, he noted *risk distribution*, a process similar to that described by Bowlby (1973) where by one views the environment as being safer when with others because danger to any one person is statistically reduced. Secondly, he described *load sharing*, wherein a couple that are bonded together share the demands of emotional regulation. This happens through an on-line process as one partner may soothe another who is sad, or in the form of attachment representations internalized by the individual as a result of their bond.

While Coan (2008) asserted that secure persons make good bets in response to attachment situations, he noted that persons of insecure attachment styles may make poor bets with regards to their resources. Such persons may utilize more cognitive resources than necessary, continuing to perceive their environment as threatening and to engage in emotional control strategies even when supported by others.

Supporting Research

Gross and Proffitt (2013) have noted increasing support for the notion that individuals adjust their perceptions of the environment based on the availability of resources. They have

noted for instance from the work of Proffitt and colleagues (1995) that when persons are asked to imagine being with a supportive other, they estimate the slant of a hill to be lower than when people imagine themselves with someone who is not supportive or alone. As such, persons become discouraged from using energy even on the basis of the availability and proximity of social support.

Coan, Schaefer and Davidson (2006) engaged in one of the earliest tests of SBT constructs. These writers observed the brains of 16 married women with functional magnetic resonance imaging (fMRI) while viewing visual symbols which indicated safety or being in danger of electric shock. These women held the hands of their husband, a male stranger or were alone. The authors found that women who held the hands of their husband or a stranger experienced reduced neural activity in areas associated with bodily arousal and "affect-related action" such as the ventral Anterior Cingulate Cortex (vACC) along with areas related to musculoskeletal and visceral response like the supramarginal gyrus, posterior cingulate and postcentral gyrus. Women experienced additional benefits over these in the spousal hand holding condition compared to the stranger hand-holding condition, however. Coan and colleagues noted that women in this condition also experienced lower activity in brain regions associated with emotional regulation such as the caudate and dorsolateral Prefrontal Cortex (dlPFC), as well as "homeostatic functions" such as in the superior colliculus (Coan et al., 2006, p. 1037). Consistent with this observation, they noted that while both stranger and spouse hand-holding resulted in lower bodily arousal only spousal hand-holding resulted in lower self-reports of unpleasantness related to the task.

Coan and colleagues (2013) later followed up the study of Coan, Schaefer and Davidson (2006) exploring the construct of mutuality, which they noted referred to one's interest in the

experiences and perceptions of the partner and willingness to share one's own experiences and perceptions. They noted that when they controlled for mutuality, the previous handholding effect disappeared. They discovered that other mutuality, referring to the woman's sense that her partner was there for her and interested in her experiences, explained reduction in emotional regulation resources, particularly in the dlPFC, and that women who reported having better relationships with their husband appeared to experience greater benefit across handholding interventions. They noted that this may signify that women who experienced greater mutuality with their spouses generally perceived their environments to be less threatening even when without the spouse. As such, insofar as perception of partner mutuality may be influenced by one's attachment characteristics, further research ought to continue exploring these concepts of *risk reduction* and *load sharing* as they are influenced by attachment.

Johnson and colleagues (2013) appeared to be the first to test SBT in the context of couples therapy. Female partners of 23 Canadian couples were imaged with fMRI while observing visual cues for safety or electrical shock when holding the hand of a spouse, stranger or being alone in similar form to the study by Coan and colleagues (2006) before and after they went through sessions of Emotion-Focused Couples Therapy (EFT) with their spouse. EFT lasted an average of 22.9 sessions (SD = 6.6) over 3.25 to 8.75 months and terminated after couples met the goals of "softening" or demonstrating greater vulnerability and "sharing of attachment related needs between the partners" as well as "consolidation" where they reviewed their gains with the therapist (Johnson et al., 2013, p. 3).

Results suggested that the EFT intervention influenced brain activity at all of the regions expected by the authors to be associated with threat appraisal. The most robust effects from the therapeutic intervention came from holding the hand of one's spouse, though the authors noted

that holding the hand of the stranger demonstrated stronger than expected results, particularly in those couples that were most distressed.

The authors reported particularly significant results in the dorsal anterior cingulate cortex (dACC) and prefrontal cortex (PFC). They described that the dACC is theorized to active in response to expectancy violations in processing negative affect and pain, while dorsolateral (dlPFC) and inferior prefrontal cortices (iPFC) have been associated with a variety of "psychological moderators of negative affect and avoidance" (Johnson et al., 2013, p. 7). They noted that the dlPFC is particularly associated with self-control strategies related to cognitive reappraisal of uncomfortable emotional states.

Consistent with Coan and colleagues (2013), reduction in dlPFC activity was only significantly seen with spousal handholding. Johnson and colleagues (2013) noted that this may be related to the concept of *load sharing*. They describe that mental efforts mediated by the PFC are bioenergetically expensive, placing one under pressure to conserve these resources. In load sharing, one shares goals and responsibilities with one's partner. They suggested, then, that the observed reduction in dlPFC activity may relate less to an increase in self-regulatory capabilities when with the spouse but rather to a reduction in threat perception as consequence of threat is shared with the partner, resulting in less of a need to control oneself.

In distressed couples that experienced greater self-regulation during stranger handholding, the authors theorized that this issue may relate to simple *risk distribution* (Johnson et al., 2013). That is, being with a stranger promotes regulation by engaging the feeling that there is "safety in numbers" (Johnson et al., 2013, p. 8). In support of this, the authors found less activity in the ventral portions of the ACC and also in the Periaqueductal Gray, both implicated in perception of "acute arousal and defensive motor planning" (Johnson et al., 2013, p. 8).

Interestingly, in the alone condition, after EFT treatment, activity related to pain threat increased in parts of the PFC and dACC (Johnson et al., 2013). The authors speculated that this might be because a consequence of developing greater dependence on social support might be a reduced tolerance for negative states when on one's own. While positivity ratings for participants in the alone condition did not change, their agitation decreased, suggesting that they still developed greater self-regulation skills when on their own as a result of the EFT intervention.

This study yielded several important results. First, past perceptions that particular brain regions are involved in threat perception, valence of perception and arousal were affirmed. Secondly, these results demonstrated that attachment health is related to threat appraisal. Thirdly, and possibly most significant, the outcomes of this study demonstrate that therapeutic interventions can adjust the influence of a couple's attachment to one another on pain-related threat. Future research, then, can proceed with greater confidence that the observed brain regions can be used as outcome measures. Moreover, this study informs interpretations of reduction in threat-related activity as relates to attachment as potentially being influenced by load sharing or risk distributing properties.

In conclusion, in keeping with SBT, attachment is capable of influencing emotional regulation strategies by adjusting one's perception of threat within the environment (Coan, 2008). This adjustment of perceived threat appears to occur by way of altered patterns of metabolic activity in a variety of brain regions according to the source of that social support. Social support from a close other appears to influence threat perception through diminishing the need for metabolically costly emotional control strategies, while social presence of unfamiliar others may more likely reduce one's perceived need to mobilize self-preservative, fight-or-flight resources consistent with defensive motor planning and physiological arousal.

Event-Related Potentials and the P300

Given that I will be using the event-related potentials technique to measure P300 amplitudes for participants it would benefit further discussion to address the nature of this methodology and measurement. Luck (2005) has noted that electroencephalography (EEG) was created by Hans Berger in 1929. Berger amplified the electrical signals in the brain from the scalp and plotted their voltage over time. The event-related potentials (ERP) technique, as mentioned earlier, time locks the observed electrical activity to particular stimuli, so that one's reaction to those stimuli may be observed in the waveform.

Polich (2007) has noted that the P3 component, sometimes referred to as the P300, is composed of a P3a and a P3b. The P3a appears to be dopaminergic and frontal and is elicited in response to surprising stimuli, while the P3b appears to be noradrenergic and located in more temporal and parietal regions of the brain, being elicited by the presentation of stimuli that one is to search for out of a sequence of other stimuli. Components are often described in terms of their amplitude, which is measured by subtracting the baseline electrical value from the highest peak. Polich (2007) has noted that research is almost always referring to the P3b.

One of the most common ways that the P3b is elicited is through the oddball paradigm (Polich, 2007). In the oddball paradigm, one is asked to seek out a comparatively less frequent "target" stimuli from a sequence of more frequent "standards," often indicating observation with a button-press. Polich has described the oddball to be a reliable clinical assay, and stated that test-retest reliability for P3b amplitude in oddball experiments tends to range between 0.5 and 0.8.

ERP, Threat and Emotional Adjustment

Several recent studies have emerged to investigate the relationship between the P300 and threatening or negative content though the literature is somewhat mixed. Fraedrich, Lakatos and Spangler (2010) have investigated difference in emotion perception among mothers who were secure or insecure-dismissing in attachment style as measured by the Adult Attachment Projective (AAP). Their sample included 16 German mothers (9 insecure and 7 secure). Their experiment included an oddball paradigm where women were asked to push a button in response to a target of a particular emotion in a baby picture (happy or sad), when that search took place with standards that were of the opposite emotion or a flower. The authors found no difference in attention to positive or negative baby faces by attachment style, though they found that women with secure attachment demonstrated higher P300 amplitudes in response to baby pictures of either emotion among flower standards. This may be because the oddball technique requires stimuli and standards to be different (Polich, 2007) and so the comparative difference between flowers and faces may have produced a larger P300 than viewing the comparative shift between faces in the context of their paradigm. Still the authors suggested that mothers who were secure were more attuned to faces than those who were dismissive.

Mark, Guerdes and Becker (2012) performed a clearer ERP study of attachment with the oddball paradigm. Using a sample of 25 female students (mean age of 22.4 years, SD = 1.2) who were neurologically healthy, these authors studied how attachment anxiety and avoidance as measured by the Attachment Styles Questionnaire (ASQ) related to approach avoidance behaviors indexed by the N100/P200 and P300 components while completing four oddball tasks. The authors described that the N100 is related to “attentional processing” while the P200 represents “early stimulus discrimination” and the P300 is though to be “augmented to emotionally salient stimuli in comparison to neutral stimuli” and that greater amplitudes for the

P300 related to some form of deeper processing (Mark, Guerdes & Becker, 2012, p. 130). During these four oddball tasks, participants were instructed to pick out angry target faces among neutral frequents and vice versa, as well as fearful target faces among neutral frequents and vice versa. The authors also attempted to understand how personality traits like autonomy (measured by the Autonomy-Connectedness Scale; ACS), along with anxiety and depression (as measured by the Symptom Checklist-90; SCL-90) influenced participants' attention to the target faces in question.

The authors analyzed their data for the P300 using ANOVA with three variables (oddball task, electrode site, and hemisphere) (Mark, Guerdes & Becker, 2012). After Bonferroni correction, the authors found only a significant effect for one oddball task where the angry faces were targets among neutral frequents. They found no significant effect for hemisphere.
They found that P300 amplitude was related to attachment anxiety, and that women who had greater attachment anxiety demonstrated greater P300 amplitudes in response to the angry pictures. The authors noted that after controlling for anxiety on the SCL-90, the relationships previously found between secure and anxious attachment and the N100 component were no longer significant, while the P300 remained significantly positively correlated with anxious at F3 and Fz electrode sites and negatively associated to secure attachment at the F3 electrode site.

The authors noted that they expected to find that those high on attachment anxiety would develop an approach/avoidance behavioral pattern characterized by greater initial N100 and P200 amplitudes and later lesser P300 amplitudes while avoidant attachment would be related to an overall flattened waveform for the N100 and P300 indicative of avoidance. In contrast, using Pearson Product Moment correlations the authors found no effect for attachment avoidance and the opposite effect expected for attachment anxiety. Greater degrees of attachment anxiety related to lower N100 amplitudes and higher P300 amplitudes, again which remained even when

accounting for anxiety. Greater degrees of attachment security related to higher N11 and lower P300 amplitudes.

The authors appeared surprised with regards to these results, believing them to conflict with past theory on anxiety which would suggest that individuals who are anxious may be vigilant for threat but then subsequently avoid it, a pattern they suggested may exist in persons of anxious attachment as well. In contrast, they found that attention was attenuated in anxiously attached individuals initially in that such attachment was related to lower N100 amplitudes and then processing was deeper as such attachment was associated with greater P300 amplitudes. Coan's (2008) theory may offer another lens through which to interpret these findings, however, at least as relates to the depth of attentional processing suggested by the P300. Consistent with SBT, individuals who are higher in attachment anxiety may continue to regard their environment as threatening and negative even when they are supported, and so perseverate on negative stimuli. In contrast, secure persons may carry with them internal representations of their support such that they regard the environment as less threatening than anxious persons, and so do not perseverate on negative content.

Chavis and Kisley (2012) have noted that negative social biases are thought to be instrumental to the development of psychopathology such as anxiety and depression. They noted for instance that those who have negative attributional styles give more weight to aspects of themselves and their environment which are negative and are associated with depression. Demonstrating this, a recent study by Bistricky, Atchley, Ingraham and O'Hare (2014) studied the responses of 55 undergraduate participants (50-71% female depending on depressive group) to an oddball paradigm where they were instructed to push a button in response to sad faces among neutral standard faces. They noted that persons with some depression history

demonstrated greater P300 amplitudes in response to sad faces than persons who were never depressed, even if they were not currently depressed.

While depression may be associated with attention to sad faces (Bistricky et al., 2014), Chavis and Kisley (2012) have cited the work of Bar-Haim and colleagues (2007) as supporting that greater attentional bias toward threat is consistently associated with affective anxiety. In a meta-analysis of 172 studies (N = 1,768 non-anxious participants, N = 2,263 anxious participants), Bar-Haim and colleagues noted anxiety is associated with a reliable bias toward attention for threat. They noted a significant small-to medium effect size for such a bias across the literature (d = .45), while no significant effect was observed for non-anxious participants. Such biases to negative content, then, may relate to the avoidance of others (Chavis & Kisley, 2012), separating one from sources of support.

Appendix B – Prescreening Informed Consent for Undergraduate Research Pool

Study Title: Social Perception, Empathy for Pain and Attachment

Study Purpose and Rationale

The purpose of this survey is to prescreen participants for a study examining how pain and attachment influence the direction of attentional resources by looking at brain activity during a visual discrimination task after being exposed to cold pain by holding a frozen bottle for a short period of time.

Inclusion/Exclusion Criteria

To be eligible to participate in this study, you must be between 18 and 30 years old, and female. You also must have certain scores on the second prescreening measure addressing your feelings in emotionally intimate relationships.

Persons with Raynaud's Disease, aneurysm, cold urticaria, history of cardiovascular illness, chronic rheumatologic disease, diabetes, untreated blood pressure abnormalities or any other condition that may interfere with perception of pain or may interfere with safe completion of the pain task cannot participate. Participants who have a condition which could result in harm to other participants or researchers, such as a communicable disease, will also be excluded from participation in the main study.

Participation Procedures and Duration

For this portion of the study you will be asked to complete two prescreening questionnaires. One questionnaire will assess relevant demographic and health characteristics along with factors that might influence your neurological activity (e.g. history of concussion, medications, history of anxiety). The other questionnaire will assess how you feel in emotionally intimate relationships.

Data Confidentiality or Anonymity

Data collected during this study will remain confidential and no identifying information such as names will appear in any publication or presentation of the data.

Storage of Data

Survey and demographic data collected via computer will be entered into a software program and stored on the researcher's password-protected computer. If you do not qualify for the main study, you will be notified and your email will be deleted from your survey data and replaced with a participant code to de-identify it. If you do not qualify or if you qualify for the study but do not accept a lab data collection time, your data will be retained to discern how those who did not complete the main study differed from those who did. If do qualify and schedule a data collection time your email address will be deleted from the study data and replaced with a participant code after you present to the lab for the main study. Collected data will be kept for an indefinite amount of time for the purpose of future research analyses. Only members of the research team will have access to the data.

Risks or Discomforts

While filling out the online questionnaires, you will not be required to describe personal experiences, though such personal experiences may come to mind as a result of completing these questionnaires.

Who to Contact Should You Experience Any Negative Effects from Participating in this Study

Should you experience any feelings of anxiety or other unpleasant emotions, there are counseling services available to you through the Ball State University Counseling Center in Muncie, 765-285-1736.

Compensation

The prescreening for this study is anticipated to take 10-20 minutes. All persons who are enrolled in CPSY courses, eligible for the study and complete the prescreening measures will be given 0.5 research credits. Participants who are ineligible for reasons explicitly stated in the informed consent will not be eligible for research credit. Those persons who are ineligible for reasons not explicitly stated (ex. a health condition not specified which would make the pain task unsafe) will be given 0.5 research credits. If participants choose to not complete the prescreening measures they will be given no research credit. The main study is anticipated to take approximately 1-1½ hours to complete.

Voluntary Participation

Your participation in this study is completely voluntary and you are free to withdraw your permission at any time for any reason without penalty or prejudice from the investigator or any investigator involved in CPSY research pool studies. If you choose to withdraw, data already collected will be retained to study how people who withdrew from the study differ from people who completed the study. If you request for your data to be destroyed it will be destroyed immediately. Please feel free to ask any questions of the investigator before signing this form and at any time during the study.

IRB Contact Information

For one's rights as a research subject, you may contact the following: For questions about your rights as a research subject, please contact the Director, Office of Research Integrity, Ball State University, Muncie, IN 47306, (765) 285-5070 or at irb@bsu.edu.

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Study Title Social Perception, Empathy for Pain and Attachment

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Consent

After having read and understood the informed consent, I choose to participate in this prescreening survey.

After having read and understood the informed consent, I choose to NOT participate in this prescreening survey.

Appendix C – Main Study Informed Consent for Undergraduate Research Pool

Study Title: Social Perception, Empathy for Pain and Attachment

Study Purpose and Rationale

The purpose of this study is to examine how pain and attachment influence the direction of attentional resources by looking at brain activity during a visual discrimination task after being exposed to cold pain by holding a frozen bottle for a short period of time.

Inclusion/Exclusion Criteria

To be eligible to participate in this study, you must be between 18 and 30 years old, female and you had to have particular scores on the prescreening measure related to feelings in intimate relationships.

Persons with Raynaud's Disease, aneurysm, cold urticaria, history of cardiovascular illness, chronic rheumatologic disease, diabetes, untreated blood pressure abnormalities or any other condition that may interfere with perception of pain or may interfere with safe completion of the pain task cannot participate. Participants who have a condition which could result in harm to other participants or researchers, such as a communicable disease, will also be excluded from participation in the main study.

Participation Procedures and Duration

You will be prepared for an electroencephalograph (EEG) recording session and your brain activity will be measured while completing a computerized task. For the EEG recording you will be asked to wear a tight cloth cap and electrodes will be secured to the cap and to several locations on the face using a non-toxic gel.

Before the computerized task you will hold a cold bottle in your hand to induce cold pain. You may stop the procedure and put down the cold bottle at any time. While holding the cold bottle, another participant will observe you from another room, and subsequently fill out a rating of their empathy for your pain as well as a general empathy assessment. Before the computer task begins, you will see the participant's rating of their empathy for your pain.

The computerized task you will be asked to complete involves discriminating between two sets of images and responding by clicking the appropriate button on a button box. While you perform the computerized task, your neural activity will be recorded in the next room and your progress will be monitored using a video camera. The video feed is passive and will not be recorded. The experiment should take approximately 1-1½ hours to complete.

Data Confidentiality or Anonymity

Data collected during this study will remain confidential and no identifying information such as names will appear in any publication or presentation of the data.

Storage of Data

Signed informed consent documents will be stored in the locked neuroscience lab (067) until completion of the study, after which they will be stored in the faculty advisor's locked office.

Survey and demographic data collected via computer will be entered into a software program and stored on the researcher's password-protected computer. EEG data will be stored on a password protected computer in the locked neuroscience lab (067) and on the researcher's password protected computer. Collected data will kept for an indefinite amount of time for the purpose of future research analyses. Only members of the research team will have access to the data.

Risks or Discomforts

You will experience an unpleasant sensation when holding the cold bottle. This will only be for a brief period of time and you have the right to stop the cold procedure at any time.

It is also possible you may feel some discomfort while being prepared for the EEG recording. Gel will be placed in holes in the cap and will get into your hair. The gel is non-toxic and washes out easily with a shower. You may quit the study at any point if you feel uncomfortable or do not wish to continue.

Who to Contact Should You Experience Any Negative Effects from Participating in this Study

Should you experience any feelings of anxiety or other unpleasant emotions, there are counseling services available to you through the Ball State University Counseling Center in Muncie, 765-285-1736.

Compensation

The study is anticipated to take approximately 1-1½ hours. All persons who are enrolled in CPSY courses and complete the study will be given 1.5 research credits. If participants choose to withdraw from the study or are withdrawn by a researcher due to ineligibility they will receive credit equal to the amount of time spent in the study. Participation under 1 hour will earn 0.5 research credits, 1 hour to under 1.5 hours will earn 1 research credit, 1.5 hours or more will earn 1.5 research credits. Participants who ask that their data be destroyed will still earn research credit commensurate with their time in the study as described above. Participants who are not able to complete the study due to technical malfunction will be given the full 1.5 research credits.

Voluntary Participation

Your participation in this study is completely voluntary and you are free to withdraw your permission at any time for any reason without penalty or prejudice from the investigator or any investigator involved in CPSY research pool studies. If you choose to withdraw or are found ineligible for the study, data already collected will be retained to study how people who withdrew from the study differ from people who completed the study. If you request for your data to be destroyed it will be destroyed immediately. Please feel free to ask any questions of the investigator before signing this form and at any time during the study.

IRB Contact Information

For one's rights as a research subject, you may contact the following: For questions about your rights as a research subject, please contact the Director, Office of Research Integrity, Ball State University, Muncie, IN 47306, (765) 285-5070 or at irb@bsu.edu.

Study Title Social Perception, Empathy for Pain and Attachment

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Consent

I, _____, agree to participate in this research project entitled, "Social Perception, Empathy for Pain and Attachment." I have had the study explained to me and my questions have been answered to my satisfaction. I have read the description of this project and give my consent to participate. I understand that I will receive a copy of this informed consent form to keep for future reference.

To the best of my knowledge, I meet the inclusion/exclusion criteria for participation (described on the previous page) in this study.

_____ _____

Participant's Signature Date

Researcher Contact Information

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Appendix D – Recruitment Email for Undergraduate Reserach

Email Subject Line: Participants Needed for Brain Study

Hello,

I am seeking participants for a study examining patterns of brain activity during a visual discrimination task.

The study will be held in North Quad 067 and 069 and will take approximately 1-1½ hours of your time.

Prior to scheduling a data collection session in the lab, you will need to complete two prescreening measures on-line to determine your eligibility for the study.

If selected for the main experiment, you will work with another participant to help expand our understanding of how people give and receive empathy for pain. The experimental procedure will involve tasks like filling out a survey, holding a cold bottle to stimulate cold pain for a brief period and completing a computerized task. Those who participate in the main study can earn credit for CPSY courses.

Qualifications for participation: In order to participate in this study you must be between 18 and 30 years old at the time of the study, and female. You must also have certain scores on one of the prescreening measures addressing your feelings in intimate relationships.

Persons with Raynaud's Disease, aneurysm, cold urticaria, history of cardiovascular illness, chronic rheumatologic disease, diabetes, untreated blood pressure abnormalities or any other condition that may interfere with perception of pain or may interfere with safe completion of the pain task cannot participate. Participants who have a condition which could result in harm to other participants or researchers, such as a communicable disease, will also be excluded from participation in the main study.

Compensation: The prescreening measures are estimated to take 10-20 minutes to complete. All persons who are enrolled in CPSY courses who are eligible for this study and complete the prescreening measure will earn 0.5 research credits. If participants do not complete the prescreening measure they will receive no research credit.

The main experiment is anticipated to take approximately 1-1½ hours. Persons who are enrolled in CPSY courses and complete the main experiment will earn an additional 1.5 research credits to that earned from prescreening for a total of 2 research credits. If participants choose to withdraw from the study or are withdrawn by a researcher due to ineligibility they will receive credit equal to the amount of time spent in the study. Participation under 1 hour will earn 0.5 research credits, 1 hour to under 1.5 hours will earn 1 research credit, and 1.5 hours or more will earn 1.5 research credits. Participants who are not able to complete the study due to technical malfunction will be given the full 1.5 research credits.

If you're interested in participating, please take the pre-screening survey at https://bsu.qualtrics.com/SE/?SID=SV_02lFGRMmqKfLJTD.

Thank you!

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Appendix E – Prescreening Informed Consent for Ball State Communications Center

Study Title: Social Perception, Empathy for Pain and Attachment

Study Purpose and Rationale

The purpose of this survey is to prescreen participants for a study examining how pain and attachment influence the direction of attentional resources by looking at brain activity during a visual discrimination task after being exposed to cold pain by holding a frozen bottle for a short period of time.

Inclusion/Exclusion Criteria

To be eligible to participate in this study, you must be between 18 and 30 years old, and female. You also must have certain scores on the second prescreening measure addressing your feelings in emotionally intimate relationships.

Persons with Raynaud's Disease, aneurysm, cold urticaria, history of cardiovascular illness, chronic rheumatologic disease, diabetes, untreated blood pressure abnormalities or any other condition that may interfere with perception of pain or may interfere with safe completion of the pain task cannot participate. Participants who have a condition which could result in harm to other participants or researchers, such as a communicable disease, will also be excluded from participation in the main study.

Participation Procedures and Duration

For this portion of the study you will be asked to complete two prescreening questionnaires. One questionnaire will assess relevant demographic and health characteristics along with factors that might influence your neurological activity (e.g. history of concussion, medications, history of anxiety). The other questionnaire will assess how you feel in emotionally intimate relationships.

Data Confidentiality or Anonymity

Data collected during this study will remain confidential and no identifying information such as names will appear in any publication or presentation of the data.

Storage of Data

Survey and demographic data collected via computer will be entered into a software program and stored on the researcher's password-protected computer. If you do not qualify for the main study, you will be notified and your email will be deleted from your survey data and replaced with a participant code to de-identify it. If you do not qualify or if you qualify for the study but do not accept a lab data collection time, your data will be retained to discern how those who did not complete the main study differed from those who did. If do qualify and schedule a data collection time your email address will be deleted from the study data and replaced with a participant code after you present to the lab for the main study. Collected data will be kept for an indefinite amount of time for the purpose of future research analyses. Only members of the research team will have access to the data.

Risks or Discomforts

While filling out the online questionnaires, you will not be required to describe personal experiences, though such personal experiences may come to mind as a result of completing these questionnaires.

Who to Contact Should You Experience Any Negative Effects from Participating in this Study

Should you experience any feelings of anxiety or other unpleasant emotions, there are counseling services available to you through the Ball State University Counseling Center in Muncie, 765-285-1736.

Compensation

The prescreening for this study is anticipated to take 10-20 minutes. If you are invited to participate in the main study, you will be eligible to earn $10 per hour. The main study is anticipated to take approximately 1-1½ hours to complete. No compensation is offered for the prescreening.

Voluntary Participation

Your participation in this study is completely voluntary and you are free to withdraw your permission at any time for any reason without penalty or prejudice from the investigator or any investigator involved in CPSY research pool studies. If you choose to withdraw, data already collected will be retained to study how people who withdrew from the study differ from people who completed the study. If you request for your data to be destroyed it will be destroyed immediately. Please feel free to ask any questions of the investigator before signing this form and at any time during the study.

IRB Contact Information

For one's rights as a research subject, you may contact the following: For questions about your rights as a research subject, please contact the Director, Office of Research Integrity, Ball State University, Muncie, IN 47306, (765) 285-5070 or at irb@bsu.edu.

Researcher Contact Information

Principal Investigator:

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Study Title Social Perception, Empathy for Pain and Attachment

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Consent

After having read and understood the informed consent, I choose to participate in this prescreening survey.

After having read and understood the informed consent, I choose to NOT participate in this prescreening survey.

Appendix F – Main Study Informed Consent for Ball State Communications Center

Study Title: Social Perception, Empathy for Pain and Attachment

Study Purpose and Rationale

The purpose of this study is to examine how pain and attachment influence the direction of attentional resources by looking at brain activity during a visual discrimination task after being exposed to cold pain by holding a frozen bottle for a short period of time.

Inclusion/Exclusion Criteria

To be eligible to participate in this study, you must be between 18 and 30 years old, female and you had to have particular scores on the prescreening measure related to feelings in intimate relationships.

Persons with Raynaud's Disease, aneurysm, cold urticaria, history of cardiovascular illness, chronic rheumatologic disease, diabetes, untreated blood pressure abnormalities or any other condition that may interfere with perception of pain or may interfere with safe completion of the pain task cannot participate. Participants who have a condition which could result in harm to other participants or researchers, such as a communicable disease, will also be excluded from participation in the main study.

Participation Procedures and Duration

You will be prepared for an electroencephalograph (EEG) recording session and your brain activity will be measured while completing a computerized task. For the EEG recording you will be asked to wear a tight cloth cap and electrodes will be secured to the cap and to several locations on the face using a non-toxic gel.

Before the computerized task you will hold a cold bottle in your hand to induce cold pain. You may stop the procedure and put down the cold bottle at any time. While holding the cold bottle, another participant will observe you from another room, and subsequently fill out a rating of their empathy for your pain as well as a general empathy assessment. Before the computer task begins, you will see the participant's rating of their empathy for your pain.

The computerized task you will be asked to complete involves discriminating between two sets of images and responding by clicking the appropriate button on a button box. While you perform the computerized task, your neural activity will be recorded in the next room and your progress will be monitored using a video camera. The video feed is passive and will not be recorded. The experiment should take approximately 1-1½ hours to complete.

Data Confidentiality or Anonymity

Data collected during this study will remain confidential and no identifying information such as names will appear in any publication or presentation of the data.

Storage of Data

Signed informed consent documents will be stored in the locked neuroscience lab (067) until completion of the study, after which they will be stored in the faculty advisor's locked office.

Survey and demographic data collected via computer will be entered into a software program and stored on the researcher's password-protected computer. EEG data will be stored on a password protected computer in the locked neuroscience lab (067) and on the researcher's password protected computer. Collected data will kept for an indefinite amount of time for the purpose of future research analyses. Only members of the research team will have access to the data.

Risks or Discomforts

You will experience an unpleasant sensation when holding the cold bottle. This will only be for a brief period of time and you have the right to stop the cold procedure at any time.

It is also possible you may feel some discomfort while being prepared for the EEG recording. Gel will be placed in holes in the cap and will get into your hair. The gel is non-toxic and washes out easily with a shower. You may quit the study at any point if you feel uncomfortable or do not wish to continue.

Who to Contact Should You Experience Any Negative Effects from Participating in this Study

Should you experience any feelings of anxiety or other unpleasant emotions, there are counseling services available to you through the Ball State University Counseling Center in Muncie, 765-285-1736.

Compensation

The study is anticipated to take approximately 1-1½ hours. Participants who qualify for and participate in the main study will earn $10 per hour for a maximum of $20. Up to 1 hour of participation will earn $10 and more than one hour of participation will earn the participant $20. Participants who are not able to complete the study due to technical malfunction, who withdraw or are withdrawn by the researcher will be given monetary compensation appropriate to the amount of time spent in the study. Participants who ask that their data be destroyed will still earn financial compensation commensurate with their time in the study as described above.

Voluntary Participation

Your participation in this study is completely voluntary and you are free to withdraw your permission at any time for any reason without penalty or prejudice from the investigator or any investigator involved in CPSY research pool studies. If you choose to withdraw or are found ineligible for the study, data already collected will be retained to study how people who withdrew from the study differ from people who completed the study. If you request for your data to be destroyed it will be destroyed immediately. Please feel free to ask any questions of the investigator before signing this form and at any time during the study.

IRB Contact Information

For one's rights as a research subject, you may contact the following: For questions about your rights as a research subject, please contact the Director, Office of Research Integrity, Ball State University, Muncie, IN 47306, (765) 285-5070 or at irb@bsu.edu.

Study Title Social Perception, Empathy for Pain and Attachment

****

Consent

I, _____, agree to participate in this research project entitled, "Social Perception, Empathy for Pain and Attachment." I have had the study explained to me and my questions have been answered to my satisfaction. I have read the description of this project and give my consent to participate. I understand that I will receive a copy of this informed consent form to keep for future reference.

To the best of my knowledge, I meet the inclusion/exclusion criteria for participation (described on the previous page) in this study.

_____ _____

Participant's Signature Date

Researcher Contact Information

Principal Investigator:

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Appendix G – Recruitment Email for Ball State Communications Center

Email Subject Line: Participants Needed for Brain Study

Hello,

I am seeking participants for a study examining patterns of brain activity during a visual discrimination task.

The study will be held in North Quad 067 and 069 and will take approximately 1-1½ hours of your time.

Prior to scheduling a data collection session in the lab, you will need to complete two prescreening measures on-line to determine your eligibility for the study.

If selected for the main experiment, you will work with another participant to help expand our understanding of how people give and receive empathy for pain. The experimental procedure will involve tasks like filling out a survey, holding a cold bottle to stimulate cold pain for a brief period and completing a computerized task.

Qualifications for participation: In order to participate in this study you must be between 18 and 30 years old at the time of the study, and female. You must also have certain scores on one of the prescreening measures addressing your feelings in intimate relationships.

Persons with Raynaud's Disease, aneurysm, cold urticaria, history of cardiovascular illness, chronic rheumatologic disease, diabetes, untreated blood pressure abnormalities or any other condition that may interfere with perception of pain or may interfere with safe completion of the pain task cannot participate. Participants who have a condition which could result in harm to other participants or researchers, such as a communicable disease, will also be excluded from participation in the main study.

Compensation: The prescreening measures are estimated to take 10-20 minutes to complete. No compensation is offered for the prescreening. Participants who qualify for the main study and present for the experimental task will earn $10 per hour for a maximum of $20. Participation up to one hour will earn $10 and participation over one hour will earn the participant $20. The main experiment is anticipated to take approximately 1-1½ hours. Participants who are not able to complete the study due to technical malfunction, who withdraw or are withdrawn by the researcher will be given monetary compensation appropriate to the amount of time spent in the study.

If you're interested in participating, please take the pre-screening survey at https://bsu.qualtrics.com/SE/?SID=SV_02lFGRMmqKfLJTD.

Thank you!

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Appendix H – Response to Participants

Hello,
You have scheduled an appointment to participate in a research study about brain activity and performance on behavioral tasks. Thank you for your interest and willingness to participate!
The study will take place in NQ069 at the following time:

A few things you need to know before your session:

- Please come to the session with **DRY** hair.
    - Wet hair will make you ineligible to participate in the EEG section of the experiment and you will be asked kindly to reschedule your appointment.
- Make sure you qualify for the study!
    - You are:
        - Between the ages of 18 and 30
        - Female
- Please arrive on time. If you are unable to make your scheduled appointment, please e-mail me ASAP at jvanhoven@bsu.edu to reschedule your appointment for a more convenient time.

If you have any questions or concerns please feel free to email me at jvanhoven@bsu.edu.

I greatly appreciate your time and participation!

Appendix I – Survey Introduction

Welcome to the Survey

This is the prescreening survey for the study titled *Social Perception, Empathy for Pain and Attachment*

You will begin by completing a Health and Demographic questionnaire. Afterwards you will complete the Experiences in Close Relationships – Revised which is composed of statements addressing how you feel in emotionally intimate relationships. Remember to answer these relationship statements keeping in mind your experiences in both *past* and *present* relationships.

Appendix J – Health and Demographic Questionnaire

Health and Demographics Questionnaire

The following set of questions is to screen for factors known to affect sensory information processing as well as participant demographics. Please be as honest as possible.

1. What is your email address? _____

2. What is your date of birth? _____

3. What is your sex? _____

4. What is your sexual orientation? _____

5. What is your ethnicity? _____

6. Are you currently in a relationship? _____

7. If so, what is the duration of your present relationship? _____

8. Have you ever hit your head and experienced a concussion?
    a. Yes
    b. No

9. If yes, please explain and include the date and number of concussions experienced:_____

10. Since birth have you ever had any other medical problems
    a. Yes
    b. No

11. If yes, please explain: _____

12. Since birth have you ever been hospitalized?
    a. Yes
    b. No

13. If yes, please explain:_____

14. Do you use tobacco (smoke and/or chew)?
    a. Yes
    b. No

15. If yes, please explain:_____

16. Have you had any hearing problems?
    a. Yes
    b. No

17. If yes, please explain:_____

18. Are you on any medications?
    a. Yes
    b. No

19. If yes, please list them all including birth control:
_____

20. Do you have now or have you ever had any of the following? Select yes or no.

Neurological disorder	Yes	No
Brain disorder	Yes	No
Vascular disorder	Yes	No
Stroke	Yes	No
Learning deficiency or disorder	Yes	No
Reading deficiency or disorder	Yes	No
Attention-deficit disorder	Yes	No
Raynaud's Disease	Yes	No
Aneurysm	Yes	No
Cold urticaria	Yes	No
History of cardiovascular illness	Yes	No
Chronic rheumatologic disease	Yes	No
Diabetes	Yes	No
Untreated blood pressure abnormalities	Yes	No

20. If you checked yes for any of the items in the previous question, please describe your diagnosis briefly:
_____

Appendix K – Experiences in Close Relationships – Revised

Experiences in Close Relationships – Revised

The statements below concern how you feel in emotionally intimate relationships. We are interested in how you *generally* experience relationships, not just in what is happening in a current relationship. Respond to each statement by clicking a circle to indicate how much you agree or disagree with the statement

	1=Strongly Disagree-7=Strongly Agree						
1. It's not difficult for me to get close to my partner	1	2	3	4	5	6	7
2. I get uncomfortable when a romantic partner wants to be very close	1	2	3	4	5	6	7
3. I find it easy to depend on romantic partners	1	2	3	4	5	6	7
4. My partner really understands me and my needs	1	2	3	4	5	6	7
5. I often worry that my partner doesn't really love me	1	2	3	4	5	6	7
6. I usually discuss my problems and concerns with my partner	1	2	3	4	5	6	7
7. I find it difficult to allow myself to depend on romantic partners	1	2	3	4	5	6	7
8. I prefer not to show a partner how I feel deep down	1	2	3	4	5	6	7
9. I worry a lot about my relationships	1	2	3	4	5	6	7
10. It makes me mad that I don't get the affection and support I need from my partner	1	2	3	4	5	6	7
11. I often wish that my partner's feelings for me were as strong as my feelings for him or her	1	2	3	4	5	6	7
12. My romantic partner makes me doubt myself	1	2	3	4	5	6	7
13. I worry that I won't measure up to other people	1	2	3	4	5	6	7
14. It's easy for me to be affectionate with my partner	1	2	3	4	5	6	7
15. I find it relatively easy to get close to my partner	1	2	3	4	5	6	7
16. I prefer not to be too close to romantic partners	1	2	3	4	5	6	7
17. When my partner is out of sight, I worry that he or she might become interested in someone else	1	2	3	4	5	6	7
18. I tell my partner just about everything	1	2	3	4	5	6	7
19. I rarely worry about my partner leaving me	1	2	3	4	5	6	7
20. I do not often worry about being abandoned	1	2	3	4	5	6	7
21. My desire to be very close sometimes scares people away	1	2	3	4	5	6	7
22. I'm afraid that I will lose my partner's love	1	2	3	4	5	6	7
23. I don't feel comfortable opening up to romantic partners	1	2	3	4	5	6	7

24. I am nervous when partners get too close to me	1	2	3	4	5	6	7
25. I find that my partner(s) don't want to get as close as I would like	1	2	3	4	5	6	7
26. I talk things over with my partner	1	2	3	4	5	6	7
27. Sometimes romantic partners change their feelings about me for no apparent reason	1	2	3	4	5	6	7
28. I often worry that my partner will not want to stay with me	1	2	3	4	5	6	7
29. I worry that romantic partners won't care about me as much as I care about them	1	2	3	4	5	6	7
30. My partner only seems to notice me when I’m angry	1	2	3	4	5	6	7
31. I feel comfortable sharing my private thoughts and feelings with my partner	1	2	3	4	5	6	7
32. I feel comfortable depending on romantic partners	1	2	3	4	5	6	7
33. I'm afraid that once a romantic partner gets to know me, he or she won't like who I really am	1	2	3	4	5	6	7
34. When I show my feelings for romantic partners, I'm afraid they will not feel the same about me	1	2	3	4	5	6	7
35. It helps to turn to my romantic partner in times of need	1	2	3	4	5	6	7
36. I am very comfortable being close to romantic partners	1	2	3	4	5	6	7

Appendix L – Debriefing Form

Social Perception, Empathy for Pain and Attachment Debriefing

The purpose of this study is to look at how attention to negative social stimuli is influenced by one's attachment style and empathy for pain in women. Now that we have your brain activity recorded, we are going to look at how specific brain areas were activated while you engaged in the visual discrimination task.

The observer empathy rating that you received was assigned artificially by the researchers in order to study how different levels of empathy might influence your cognitive processing. No research participant observed your cold bottle task or provided any empathy rating.

As a result of your participation, we hope to better understand how women with differing attachment characteristics perceive social supports and psychologically adjust to chronic pain.

If you wish to withdraw your participation from this study you may still do so by either communicating this verbally to the researcher or emailing the researcher at the email address below.

Thank you very much for your time and for your participation in this study. It is very much appreciated! We ask that you please refrain from sharing details about this study with individuals who may potentially participate in this study.

Please feel free to email me if you have questions at jvanhoven@bsu.edu

Appendix M – Study Script

Experimental Procedure

1) Once the participant has been capped, close the door and notify them that one researcher will retrieve a male research participant to observe the participant's pain task from another room. Begin the E-prime practice task (See Behavioral Data Collection below).
2) Read the slides to the participant:
    a. As a part of this study we are investigating how men empathize with the pain of another person and so another male student will watch your cold bottle procedure from the other room. After this he will rate his empathy for your pain and fill out an empathy questionnaire. Because the appearance of the other research participant may influence how you receive the empathy rating, we will keep you from meeting the research participant until the end of the study. **Press any key**
    b. While the other researcher is going to retrieve the other participant, you will engage in a practice task. **Press any key**
    c. Before you begin the task, you will see the observer's empathy rating. Empathy is defined as the observer's ability to share and understand your pain. He will be asked to rate his empathy for your pain on a scale of "0" (no empathy) to "10" (complete empathy). After he has given the researcher his empathy rating, the researcher will input it into the computer. When the computer task begins, it will be presented like this: **Press any key**
    d. [Display "Empathy Rating" above "X" and a 0-10 visual analogue scale] (timed slide)
    e. Then you will work on completing the computerized task. You will see "+" followed by a face picture. Please keep your eyes fixed on the "+". You will see angry and neutral face pictures. Please press the center key on the button box when you see an angry faced picture. To try this task press any key to begin.
    f. [Researcher leaves the room. Angry/Neutral Face Task Begins]
    g. [Task Ending, no need to read] Thank you. An experimenter will return shortly.

3) The participant will then undergo the cold bottle task for 90 seconds. Verify that the cold bottle is -10°C before the task begins. Remind the participant that they can put down the cold bottle at any time.

Instructions for Using the Cold Bottle

- Remove the cold bottle from the freezer
- Test the cold bottle with the infrared thermometer making sure it is -10°C. If the wrap is lower than -10°C, let it sit out to warm up until it reaches this temperature.
- Disinfect the bottle with an alcohol wipe after use and return to freezer.

4) After a delay of approximately 1 minute, begin first E-Prime experimental block. Check counterbalancing sheet for the appropriate file.

5) Begin the appropriate main task slides (See Behavioral Data Collection below) according to what you were asked to do by the principal investigator. Read the following slides (summarizing/truncation is appropriate as the participant reads):
    a. Please rate your peak pain intensity during the cold bottle task on a scale of 0 (“no pain”) to 10 (“worst pain imaginable”).
    b. The observer has provided his empathy rating and it has been entered by a researcher. Remember that empathy refers to the observer’s ability to share and understand your pain. His empathy rating will now be displayed on the scale of “0” (no empathy) to “10” (complete empathy).
    c. [Appropriate high or low empathy number with visual analogue depiction] (timed slide)
    d. In the following task you will begin by seeing a “+” followed by face pictures. Please keep your eyes fixed on the “+”. You will see angry and neutral face pictures. Please press the center key on the button box when you see angry faced pictures. Press any key when you are ready to begin.
    e. [Researchers leave. Angry/Neutral Face Task Begins]
    f. [No need to read.] Thank you for your participation. Goodbye.